

"Ere many generations pass, our machinery will be driven by power obtainable at any point in the universe...it is a mere question of time when men will succeed in attaching their machinery to the very wheelwork of nature."

- Nikola Tesla



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ZERO POINT ENERGY

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The purpose of this document is to outline the vision of ZPower Corporation for the global commercialization of advanced energy technologies.

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ZPOWER STRATEGY DOCUMENTS

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INTRODUCTION

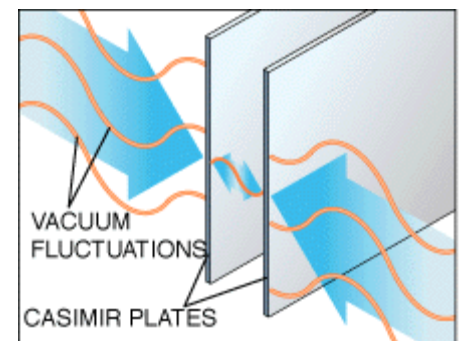
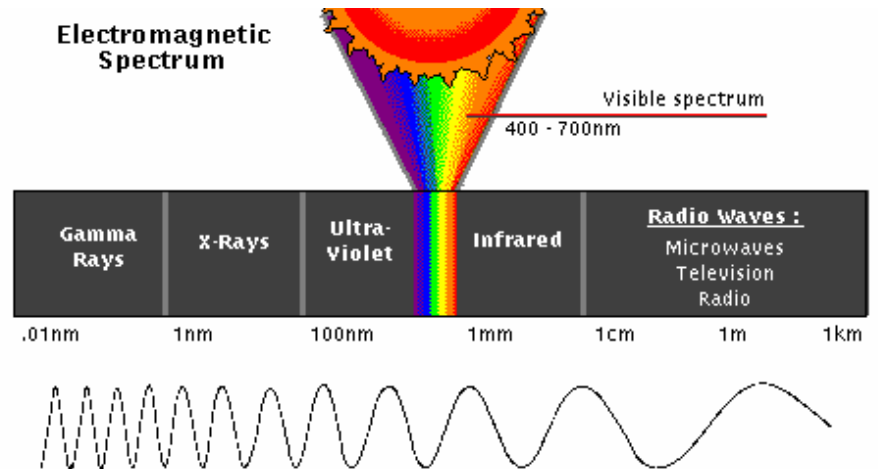
ZPower Corporation was founded to become a global leader in providing viable fuel-less and pollution-free energy alternatives that can deliver electrical, mechanical and thermal power. ZPower Corporation is developing several technologies which collect and convert energy from a previously untapped source, sometimes referred to as Zero Point Energy (ZPE).

In essence, the key is the conversion of electromagnetic radiation energy to electrical energy, and more specifically the conversion of an extremely high frequency bandwidth of the electromagnetic spectrum (beyond Gamma Rays) known as the *zero point spectrum*.

Physicists recognize that we are *immersed* in an energetic field. The existence of the zero point electromagnetic energy was discovered in 1958 by the Dutch physicist M. J. Sparnaay. Mr Sparnaay continued the experiments carried out by Hendrick B. G. Casimir in 1948 which showed the existence of a force between two uncharged plates which arose from electromagnetic energy surrounding the plates in a vacuum.

Mr Sparnaay discovered that the forces acting on the plates arose from not only thermal energy (heat) but also from another type of radiation now known as classical electromagnetic zero point energy. Mr Sparnaay determined that not only did the zero point electromagnetic energy exist in a vacuum but also that it persisted even at a temperature of absolute zero. This term Zero Point Energy (ZPE) has been based on the concept that even if matter were cooled down to absolute zero (minus 273°C), in terms of its temperature, this energy field still remains.

Because it exists in a vacuum, ZPE is homogeneous (uniform) and isotropic (identical in all directions) as well as ubiquitous (exists everywhere). In addition, the intensity of the energy at any frequency is proportional to the cube of that frequency. Consequently, the intensity of the energy field increases without limit as the frequency increases resulting in an infinite energy density for the radiation spectrum. With the introduction of the ZPE into the classical electron theory, a vacuum at a temperature of absolute zero is no

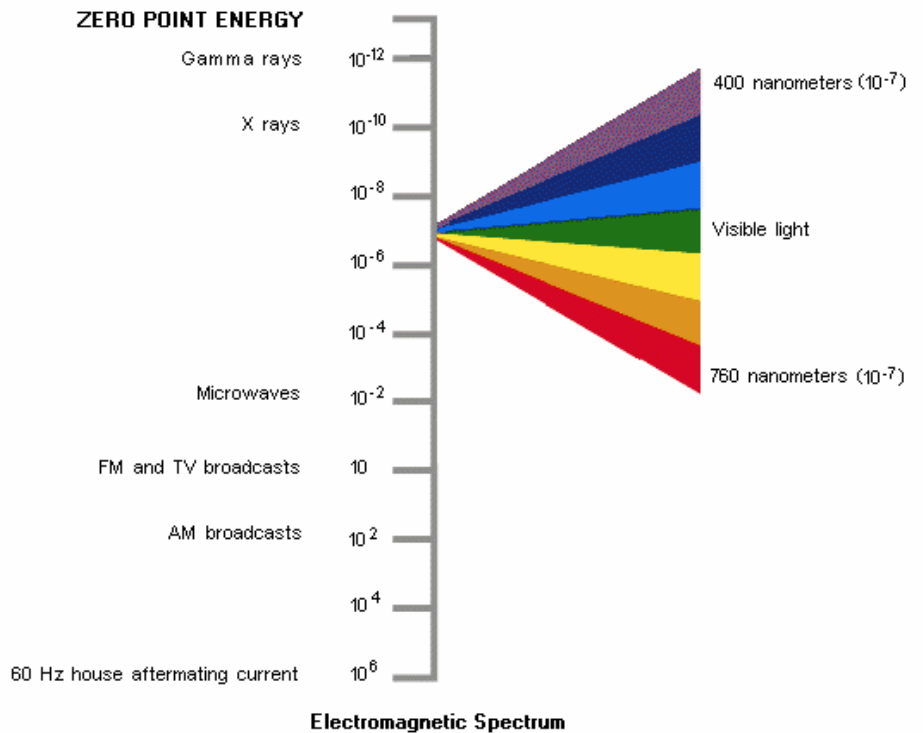


longer considered empty of all electromagnetic fields. Instead, the vacuum is now considered as filled with randomly fluctuating fields having the ZPE spectrum.

The special characteristics of ZPE are that it has a virtually infinite energy density and that it is ubiquitous (even present in outer space), which make it very desirable as an energy source. However, because high energy densities exist at very high frequencies, and because conventional methods are only able to convert or extract energy effectively or efficiently at lower frequencies, effectively tapping this energy source has been unavailable using conventional techniques. Consequently, ZPE which may be used to provide for society's demanding energy needs has remained unharnessed.

Until now...

The solution in tapping this energy source is to create an antenna, or receiver, which will operate in the extremely high frequencies of ZPE, as indicated in this chart.



It appears that this energy is quite intense. Nobel Laureate Richard Feynman and one of Einstein's protégés, John Wheeler, calculated that there is more than enough energy in the volume of a coffee cup to evaporate all the worlds' oceans. We fail to easily recognize this immense energy source as it is analogous to trying to weigh a beaker of water underneath the ocean.

Andre Sakharov, the Soviet Physicist, argued that we should regard all matter as floating in a sea of energy. Modern physics tells us that the space between the stars and the space between the particles that which make up matter are filled with vast amounts of fluctuating energy: fluctuations that are fundamental to our view of the fabric of nature.

Various researchers around the world have been discovering scientific anomalies which are being attributed to the conversion of ZPE. It is also thought that discovering the secret of tapping ZPE could be the key to opening the door to a unified theory of the Universe. In other words, our current understanding of science is like a puzzle with a large missing piece. ZPE

would be the missing piece which completes the picture, possibly ushering a "Second Coming" of science.

In essence, the implication of this energy field, is that all physical matter can be considered to be floating in a sea of energy, which if collected and converted into electrical energy, could more than meet the world's insatiable energy demand.

It is a figure that exceeds the estimated amount of energy present in the known or visible universe which includes all the energy being liberated by tens to hundreds of billions of galaxies all ablaze with millions of stars. This amount of energy is literally inconceivable by the human imagination. With this amount of energy potentially present in every cubic centimeter of vacuum, it becomes utterly ludicrous to speak of an "energy shortage" as is so often done in today's political and economic spheres. The paradigm of the zero point energy potential of the vacuum of space literally disallows scarcity from being considered to be real, that is, if we can find a way to tap into this sea of energy potential and extract some of it to do work. This is the big issue at hand and the outcome of this issue has enormous ramifications for the future existence of the human species and for that of all life on Earth.

It is safe to say that the understanding of zero point vacuum fluctuation physics is one of the more important steps that has ever occurred in the history of science. It has the potential to utterly change our view of the nature of things and may have technological ramifications that can allow us to really clean up the planet and stop destroying the biosphere in the greedy, shortsighted way that is currently going on at an ever accelerating rate. And accomplishing this miracle will set us on the road to an even greater miracle -- a fundamental shift in consciousness that can liberate humanity's imagination to the same unimaginable degree that zero point physics can liberate the energy in so-called empty space.

Zero point physics is also in profound accord with the sacred world views of nearly all spiritual traditions. It shows that everything is inseparably one, that all that manifests is arising within the same unified ocean of being. There are no separations. All of humanity and in fact the entire universe is one coherent body arising mysteriously out of the infinite source that some call God or The Great Spirit. It demonstrates and scientifically validates the spiritual verity that we have boundless resourcefulness within ourselves, within the spirit that lives in us and all things, and we can learn to draw upon that infinite reservoir of strength, resourcefulness, and yes, Love.

The Zero point paradigm provides a scientifically supported model of human potential as being literally infinite and totally open ended, something that great awakened beings have been telling us throughout the ages. This new paradigm helps us get a glimpse through the thoroughly scientific and rational approach to the staggering boundless creative potential and open-ended dynamics of the Universal Mind, of which we are all living creative expressions and with which we are all one.

"Thus he then classified living creatures into genera and species, and divided them in every way until he came to their elements, which he called the five shapes and bodies - aether, fire, water, earth and air."

XENOCRATES, ON THE LIFE OF PLATO

EXPERIMENT CONFIRMS ZERO POINT ENERGY

PATENT ISSUED TO AIR FORCE SCIENTIST

BY EUGENE MALLOVE

Not that it was a big surprise to those in the New Energy field, but it is wonderful that the existence of zero point energy -- the potential source of limitless energy for civilization -- has now been confirmed in a seminal experiment -- one that has already been acclaimed by the scientific mainstream. Of course, the "mainstream" talks of its implications for cosmology and for its "proof" of the theory of Quantum Electrodynamics (QED) -- not for technological applications.

Physicist Steven K. Lamoreaux, now of Los Alamos National Laboratory, performed an exacting, elegant experiment (while at the University of Washington in Seattle), which confirms within 5% the theoretical formula for the Casimir force, which was proposed in 1948. This is the force that is said to be due to "virtual photons" popping in and out of existence in the vacuum of space. Specifically, it is the force that appears prominently when physical objects are in very close proximity. Then, the tiny region between two objects--such as two closely spaced flat plates--excludes the longer wavelength spectrum of electromagnetic radiation that pervades space. So there is an inward pressure that creates the Casimir force. (see R.L. Forward's tutorial article on ZPE in IE #9 pp.53-64)

The Lamoreaux paper, "Demonstration of the Casimir Force in the 0.6 to 6 pm Range," appeared in *Physical Review Letters*, 6 January 1997, Vol.78, No.1, pp. 5-8. The abstract is succinct: "The vacuum stress between closely spaced conducting surfaces, due to the modification of the zero-point fluctuations of the electro-magnetic field, has been conclusively demonstrated. The measurement employed an electromechanical system based on a torsion pendulum. Agreement with theory at the level of 5% is obtained."

The actual experiment employed a spherical-shaped gold-coated plate in near-contact with a flat plate-facilitating precise electromechanical adjustments to measure the forces, which would have been more difficult with two flat plates. The Casimir force formula was verified down to a separation distance of 0.6 um.

The response to this experiment has been noteworthy. Writing in *Nature*, science writer Charles Seife began: "There is no such thing as a free lunch--except in quantum mechanics. Classical physics -- and common sense --

dictates that the vacuum is devoid not only of matter but of energy. But quantum mechanics often seems to depart from common sense." It would have been nice had this comment led in the article into the potential technological implications of the experiment. But alas, no! Seife quoted University of Sussex physicist, Malcolm Boshier: "This is one of those experiments that is going to wind up in all of the textbooks."

Malcolm W. Brown's story in the New York Times (January 21, 1997, C.I, C.6), was titled. "Physicists Confirm the Power of Nothing, Measuring Force of Quantum 'Foam'" However, Mr. Brown, as usual, ignored the technological implications in favor of outlandish concepts having to do with theoretical cosmology. First off his pen was, "...something might cause the present day universal vacuum to collapse into a different vacuum of lower energy. The effect, propagating at the speed of light, would be the annihilation of all matter in the universe. There would be no warning for humankind: the earth and all its inhabitants would simply cease to exist at the instant the collapsing vacuum reached the planet." Brown quoted cosmologist Dr. Michael Turner of Fermilab: "The energy of the vacuum remains one of the deep mysteries of science. We know from quantum mechanics that it is not empty. We have much to learn." Indeed! Strangely, these cosmology-obsessed people (I confess, I used to be one of them!) do not even think of the implications for over-unity devices.

Fortunately, others have been thinking of such devices. Air Force scientist Franklin B. Meade, Jr. and his colleague Jack Nachamkin have just been awarded a U.S. patent (#5,590,031) for a device to capture zero-point radiation. It employs the novel approach of capturing the beat-frequency radiation of zero point radiation frequencies. The patent is a highly significant one. Note the key connection to the Lamoreaux experiment in these words from the patent abstract: "A system is disclosed for converting high frequency zero point electro-magnetic radiation energy to electrical energy. The system includes a pair of dielectric structures which are positioned proximal to each other and which receive incident zero point electromagnetic radiation. The volumetric sizes of the structures are selected so that they resonate at a frequency of the incident radiation. The volumetric sizes of the structures are also slightly different so that the secondary radiation emitted therefrom at resonance interfere with each other producing a beat frequency radiation which is at a much lower frequency than that of the incident radiation and which is amenable to conversion to electrical energy."

Note well the comment in the patent: "The Size of the structures are preferably miniaturized in order to produce greater amounts of energy from a system located within a space or area of a given size. In this regard, the smaller the size of the receiving structures, the greater the amount of energy that can be produced by the system of the present invention."

Questions immediately arise. Could this be pointing the way to the use of nanostructures to extract ZPE? Is it possible that if this patent is sound, it points toward an explanation for the cause of cold fusion excess energy and a method for facilitating nuclear reactions? There are many things to ponder!

NEW ENERGY AGE

IS FREE UNLIMITED ENERGY REALLY A POSSIBILITY?

FIND OUT FROM TWO PHYSICISTS WHO HAVE EXPLORED THIS INTRIGUING TOPIC: HAL PUTHOFF AND STEVEN WEINBERG.

C_cox and other viewers ask:

I didn't quite understand the principle of zero-point energy on the show. Can you please give me a simple explanation of the basic theory or point me the direction where I could read about it on the web or a recent publication?

Hal Puthoff answers: A very readable summary can be found in Scientific American itself, in an article by Prof. Timothy Boyer in the August 1985 issue, entitled "The Classical Vacuum." As to the origin of the term "zero-point energy," it simply means that for any vibration (acoustic, electromagnetic, etc.) there remains, even at a temperature of absolute zero, a small residual energy that has its roots in the quantum uncertainty principle, a nonvanishing "quantum jiggle," as it were. In the context of the program, the possibility of an enormous reservoir of zero-point energy in space (the vacuum) associated with electromagnetic fields derives from the fact that although the residual energy at any given frequency is quite small (at the level of the uncertainty principle), there are contributions to the overall energy density from waves of all frequencies, propagating in all directions, and the sum of all these contributions is calculated to be quite large.

Steven Weinberg answers: Electric and magnetic fields and other fields are subject to a version of the Heisenberg uncertainty principle: it is not possible to have a state in which a field, and the rate at which it is changing, both vanish. Consequently empty space, even far from any matter, is permeated with continually fluctuating fields. The effects of these fields are very weak under ordinary circumstances, but they can be measured -- for instance, by observing a force between parallel metal plates due to the change produced by these plates in the fluctuating electric and magnetic fields in the space between the plates. This is known as the Casimir effect, and has been studied experimentally and theoretically for many years.

Cosmicaug asks:

This is a naive layperson's question which, as a genuinely naive layperson (at least when it comes to QM), I feel fully qualified to pose. The question is simply where does the energy in these quantum vacuum fluctuations come from? That is, if I installed one of these zero point energy devices in my basement to power my electric toaster in my kitchen, would I get free air conditioning in my basement every time I made toast or would the energy come from somewhere unknown (perhaps even somebody else's basement) or would it come from nowhere at all (free lunch scenario)? I am of course bypassing the issues of exactly how much of this energy is available and whether it is harnessable in some practical way and simply assuming that at some point I can buy these devices at my local hardware store and that they work as advertised.

Hal Puthoff answers: Naive layperson's questions are the best! If access to the zero-point-energy (ZPE) reservoir is successful, one needn't worry about either depletion of this resource or creating an imbalance in the local environment. It is the electromagnetic equivalent of scooping cupfuls of water out of the ocean, with replacement occurring at the velocity of propagation of electromagnetic waves, the velocity of light. As to the ultimate origin of the ZPE, two views are discussed in the physics literature: one, that it is simply part and parcel of the energetic legacy that emerged with the Big Bang, and another that it is an energetic substratum that preceded even the Big Bang, with our universe emerging as the result of a giant vacuum fluctuation. In any case an argument can be made that it is sustained by a cosmological feedback cycle in which charged particles radiate due to their "quantum jiggle," and the particles "jiggle" due to being caught up in the collective radiation of all the other particles, an electromagnetic equivalent of placing a microphone near a speaker and generating a squeal (see H. E. Puthoff, "On the Source of Vacuum Electromagnetic Zero-Point Energy," Phys. Rev. A, vol. 40, p. 4857, 1989; Phys. Rev. A vol. 44, p. 3382, 1991).

Gdecker asks:

For Hal Puthoff: You say you think the next century could be the era of zero-point energy. Do you think we're close to finding the making the breakthrough discovery that would make this scenario a reality?

Hal Puthoff answers: To my knowledge there are at present five techniques proposed to extract ZPE for use, the more promising of which are under investigation in several laboratories, and some of which have shown some small positive results. As with solar power, hot fusion, and antimatter containment, the road between emerging laboratory proof-of-principle and scaled-up, economically-competitive energy resource is a long one. In our

laboratory we are sufficiently optimistic that we are devoting a large part of our resources to this pursuit, with the expectation that within a decade we will either be confident that it is only a matter of time and engineering, or it will reveal itself to be only a laboratory phenomenon without the possibility of constituting a major energy resource. It falls into the category that we refer to jokingly as "high risk, infinite payoff," and so think it is worth pursuing until its potential is resolved one way or the other.

Biotech asks:

Could you please evaluate the "bubble theory" that Puthoff is investigating on the show. Does it sound promising to you?

Hal Puthoff answers: The "Bubble Theory" presented on the Scientific American Frontiers program (that collapsing bubbles in cavitating fluids might act as a Casimir process to convert vacuum fluctuation energy into light) is not Puthoff's theory, but rather was proposed by Nobel Laureate Julian Schwinger in a series of papers published in the early '90's in the Proc. of the National Academy of Sciences. As one of several theories put forth to explain the phenomenon of sonoluminescence (sonically-driven light phenomena), this particular theory, if true, might show an excess of heat energy in careful calorimetric measurements, and these measurements are being carried out at the Institute for Advanced Studies at Austin. So far, no excess has been found, indicating that either Schwinger's proposed mechanism is not correct, or that the percentage excess energy is vanishingly small in the experiments carried out to date.

Jmartine asks:

Professor Weinber: In the beginning of the show during your conversation with Alan Alda, you talked about how humans have a desire to see themselves at the center of things. They seem to reject a rational, scientific viewpoint of their place in the laws of nature. I've been wondering why humans would have evolved with the former attitude - surely a rational view would serve us better. Any insights?

Steven Weinberg answers: It was naturally very difficult for human beings to develop a rational, scientific view of nature before the discoveries that led to the birth of modern science in the sixteenth and seventeenth centuries. Even so, there are those who tried, such as the Greek atomists Democritus and Leucippus, their followers, Epicurus and Lucretius, and the skeptic Xenophanes. But seeing a flash of lightning or the outbreak of plague, and having no idea what these phenomena were, it was almost irresistible to regard them as supernatural interventions aimed specifically at humans.

Toddm asks:

Professor Weinberg: I wish there had been time on the show for you and Hal Puthoff to debate the existence of zero point energy. Puthoff, for example, states that there is enough energy out in space in the volume of a coffee cup to evaporate all the world's oceans. You state that the energy in space the size of the earth is probably equal to no more than a gallon of gasoline. This seems like a big difference! Can you explain how you arrived at your estimate and why you think Puthoff is incorrect?

Steven Weinberg answers: We don't have a way of reliably calculating the energy in empty space. When we try to use our present quantum field theory to do this calculation, the answer in the simplest approximation comes out infinite, which is clearly nonsense. My estimate, that the energy in a volume of empty space the size of the earth is not greater than the energy in a gallon of gasoline, is a crude upper limit that was not based on direct calculations of the energy in any fundamental theory, but was based instead on observations of the way that the universe is expanding. If the energy density in empty space were much greater than this upper limit, it would produce enormous gravitational fields, which would mean that the universe would have to be expanding much more rapidly in order to avoid collapsing, just as a rocket leaving a heavy planet like Jupiter has to travel much faster than one that leaves a lighter planet like the earth. But (as I explained in a part of my interview with Alan Alda that was not broadcast) it really doesn't matter how much energy there is in empty space. The conservation of energy tells us that if we get energy out of empty space, then we have to leave it in a condition of lower energy. But what could have lower energy than empty space?

Hal Puthoff responds: As pointed out by Prof. Weinberg, a straightforward calculation using quantum field theory does indeed yield an infinite energy density for the zero-point energy (ZPE) of empty space. What's wrong with this calculation is the assumption that electromagnetic waves of all frequencies exist and contribute to this energy density. However, physicists Sakharov, Wheeler, and others argue that, because of quantum effects, the concept of a well-behaved spacetime geometry must lose its meaning as one approaches the so-called Planck frequency (wavelength $\sim 10^{-33}$ cm) where the geometry dissolves into a quantum "foam-like structure." Assuming a high-frequency cutoff at this frequency, they estimate an energy density which, though not infinite, might as well be for all practical purposes (mass equivalent of $\sim 10^{94}$ g/cm-cubed). Feynman, arguing that what counts is not the maximum frequency available in the ZPE background, but rather the frequency at which meaningful interactions between the background and nuclei cut off, reduces this estimate further to nuclear energy densities ($\sim 10^{14}$ g/cm-cubed), still an exceedingly large number.

Why the remaining discrepancy between the high estimates given above by those who approach the problem from a quantum theoretical point of view, and the low estimates of those who, like Weinberg, approach it from a point of view of cosmology and gravitation? This discrepancy is symptomatic of a long-standing unresolved conflict between quantum theory and general relativity. If one assumes, as the cosmologists do, that the ZPE must contribute to spacetime curvature, then the lack of observable strong curvature must mean that the ZPE energy density is vanishingly small. However, the error may be in the assumption. Since this is an issue of high import, a search of the literature reveals several models that attempt to reconcile the conflict in other ways, e.g., by assuming a fine-tuned, negative-energy-density ZPE associated with fermions (e.g., protons, neutrons, electrons) that cancels that associated with bosons (e.g., photons), or that only mass-energy departures from the homogeneous ZPE background curve space.

In answer to the question "what could have a lower energy than empty space?" the answer is "an empty space with lower energy." Although one might naively assume that by definition the vacuum has zero energy and therefore can't go lower, a review of the literature shows that the vacuum state can have different energy values, and that a given vacuum state can under certain conditions decay to a state of lower energy (see, e.g., Fulcher et al., "The Decay of the Vacuum," *Sci. Am.*, vol. 241, p. 150, Dec. 1979). In the Casimir effect, for example, in which plates are driven together by ZPE forces, the vacuum with metal plates far apart is more energetic than the vacuum with metal plates closer together, so the vacuum decays to a lower-energy state, transferring its energy (by the law of conservation of energy) into the kinetic energy of the plates moving closer, finally to be released as heat when the plates collide.

Students.was.mntm.org ask:

How did people first discover the concept of zero-point energy?

Hal Puthoff replies: This was an exciting example of the play back and forth between theory and experiment. In the early days of the development of quantum theory, a slight discrepancy was noticed between the calculated and measured energy levels of excited hydrogen gas. Although the calculations were carried out using the new quantum theory, no thought had been given to the concept that perhaps the atom did not exist in a void, but rather in a sea of fluctuating electromagnetic radiation. Once the possibility was taken into account that not only material systems but fields as well were subject to fluctuations associated with the quantum uncertainty principle, then the effects of field fluctuations on the electron orbits could be taken into account, and they were found to account for the discrepancy. Measurement of this discrepancy by Willis Lamb, now called the Lamb shift, led to a Nobel prize for Lamb, and

further development of the understanding of the role of vacuum field fluctuations led to the development of quantum electrodynamics with its associated zero-point energy concept.

Nowadays, perhaps the most discussed demonstration of the zero-point energy concept is as follows. If a radio is taken into a shielded room, the stations can no longer be heard because the shielding stops the radio waves from entering. Similarly, closely-spaced metal plates slightly shield the interior region from certain frequencies of the fluctuating electromagnetic background ZPE. As a result, the radiation pressure of the waves between the plates pushing them apart is somewhat weaker than the radiation outside pushing them together. The force pushing them together is known as the Casimir force, named for its discoverer.

Students.was.mntm.org ask:

If you ever find more about this energy, how would you plan to heat a whole house? I thought that this subject was interesting. I think it would be interesting to use the energy around us to make heat or use it for other things to help us.

Hal Puthoff replies: If we are successful in finding a way to extract this energy on a scale large enough to be useful for such applications, and assuming that the process is efficient and environmentally friendly (that is, no harmful side effects such as radioactivity), then the most likely form it would take would be as a generator of heat. In this case a ZPE heater would simply constitute a stand-alone replacement unit for whatever heating unit is presently in use. If a process can be found to convert vacuum fluctuation energy into an electrical form efficiently, then batteries with an exceptionally long lifetime might result. However, I would also caution that it is too early to tell whether laboratory ZPE phenomena can be developed into a useful energy source. As with nuclear fusion, the steps between emerging laboratory results and market-competitive energy source are many. But, as the Chinese proverb says, a journey of 1000 miles begins with the first steps, and these steps are now being taken in many laboratories around the world.

Brittany asks:

I think the concept of a never-ending, free energy sources is fascinating! But I don't really understand why we haven't mastered it yet. The clock on the show represented how air pressure, or barometric pressure, can cause a simple spring to wind. Couldn't this technology be put to use in some other fashion, or if it's form didn't change, isn't there any way we can use it?? Thank you.

Hal Puthoff answers: Actually, when you think of it, there are a number of sources of the natural type (like the barometric pressure) that have been mastered and are used to produce energy. Niagara Falls is a good example, where the falling water drives turbines to drive generators to generate electricity. The water eventually is recycled by evaporation into rain clouds, then rain and the upstream river, with the energy recharge being accomplished by the sun in the evaporation part of the cycle. Geothermal activity in such places as Iceland is also used to produce energy. Solar power can be used effectively under certain conditions. There are even prototype devices to harness the tides and ocean currents, but these are not yet very effective. The use of fossil and nuclear fuels to release stored energy is, of course, a major example of the use of natural processes, in this case chemical and nuclear reactions. In this light, attempts to harness zero point energy are just a recent addition to a long list of harnessing energetic processes we find in our natural environment.

Ejaxon asks:

I've always been interested in space travel ever since I was very young. I was wondering if zero point energy could possibly power space ships. Could it? If it could then we could be making trips to farther off places than the moon and maybe I could go to Mars someday?

Hal Puthoff answers: Although it is still too early in the research to know whether the zero-point energy can be tapped at levels sufficient to power a space ship, without a doubt it would make an ideal fuel since it is presumably available everywhere in space and therefore need not be carried on board. A recent (August 1997) NASA workshop on "Breakthrough Propulsion Physics" at NASA's Lewis Research Center in Cleveland addressed this very possibility. I have myself explored this topic in an article this year, "Space propulsion: Can empty space itself provide a solution?" published in the Jan/Feb 1997 issue of "Ad Astra," the magazine of the National Space Society, headquartered in Washington, DC.

Twilcox asks:

If you can tap into zero-point energy, say to turn on some local light source, then does the energy regional depletion affect local gravitational fields as they evolve in time? If local energy gets restored through some kind of cosmic accounts balancing principle, does the second law of thermodynamics become a casualty of the new physics?

Hal Puthoff answers: Since zero-point energy fields are simply a special case of electromagnetic field distribution, I would assume that any regional depletion would be restored at the velocity of light, the EM equivalent of

scooping cupfuls of water out of the ocean. Therefore I would not anticipate an evolving gravitational anomaly associated with the process. As for the second law, I do not see it in danger of becoming a casualty of the new physics (more precisely, the new application, as the physics is standard). For example, Casimir plates in the vacuum can be considered coupled to an open system, and when driven together by vacuum forces, the vacuum has decayed to a lower energy state and heat has been generated by the collision of the plates, pretty standard stuff. For a more detailed discussion of the thermodynamic aspects of zero-point energy extraction, see D.C. Cole and H.E. Puthoff, "Extracting energy and heat from the vacuum," Phys. Rev. E, vol. 48, p. 1562, 1993.

SPACE DRIVE: A FANTASY THAT COULD BECOME REALITY

BY ARTHUR C CLARKE

Introduction by Pat Dasch, Ad Astra Magazine

I wrote to Arthur C. Clarke, who serves on the Society's Board of Governors, in June, asking if he would contribute an assessment of how far we had traveled during the Society's 20 years and where we saw space exploration leading in the next 20 years. His initial response was enthusiastic, but demands for similar review pieces around the time of the Apollo 25th anniversary drew a fax that read, "I am exhausted from writing no less than six articles on space and [the] future in the past few weeks." You may have seen some of these pieces: they appeared in The Washington Post, Nature, Space News, the London Times and GQ magazine in the United Kingdom.

Clarke suggested I might wish to negotiate reprinting one of those pieces but concluded his fax: "I am also mailing you a short piece about space drives which you are free to use." The piece that duly arrived by snail mail has fairly short: a concise encapsulation of a possibility that had captured the author's attention. Indeed, the piece, which is printed below, is a prime example of that visionary quality of Clarke's work that we all admire so much-a quality that alas, is missing from most current pronouncements on space strategy for tomorrow.

Science-fiction writers have long dreamed of a mythical "Space Drive" that would allow us to go racing round the universe-or at least the solar system-without the rocket's noise, danger and horrendous expense. Until now, this has been pure fantasy, and it may always be so. However, recent theoretical studies published by Haisch, Rueda and Puthoff in *Physics Review A* in February of this year and based on some ideas put forward by the great Russian physicist and human rights campaigner, Andrei Sakharov, hint that some control may indeed be possible over the mysterious forces of gravity and inertia. (Warp Five, anyone?)

These conjectures-they are no more at the moment-depend on the astounding discovery that so-called empty space is actually a cauldron of seething energies, known technically as "quantum fluctuations" which have been detected but not yet tapped. If they can be, the impact upon our civilization will be incalculable. Oil, coal, nuclear, hydropower, would become obsolete-and so would many of our wrapped up in one big worry-heat

pollution. All energy eventually degrades to heat, and if everyone had a few million horsepower to play with, this planet would soon be heading the way of Venus -- several hundred degrees in the shade. However, there is a bright side to the picture: there may be no other way of averting that next Ice Age, which otherwise is inevitable.

I cannot help wondering if quantum fluctuations (also known as Zero Point Energy) explain some of the baffling and bizarre results reported by advocates of so-called "Cold Fusion" such as Drs. Pons and Fleischmann, who claimed in 1989 to have produced nuclear energy in a test tube at room temperature. At the moment the scientific establishment is completely polarized on the subject: probably 95% of chemists and physicists are sure the whole thing is nonsense-or even fraud-while 5% believe that some anomalous phenomenon is occurring, though it may not be fusion, and it certainly isn't cold. Time will settle the matter, as it always does. Don't sell your oil shares yet-but don't be surprised if the world again witnesses the four stages of response to any new and revolutionary development: 1. It's crazy! 2. It may be possible-so what? 3. I said it was a good idea all along. 4. I thought of it first.

Arthur C. Clarke is a member of the NSS Board of Governors and Chancellor of the International Space University.

VOLATILE VACUUMS

BY OWEN DAVIES, OMNI MAGAZINE

Imagine a world in which end-less, nonpolluting, and virtually free energy powers our cities, cars, and homes. Envision laptop computers more powerful than today's largest, most sophisticated mainframes, and tiny X-ray machines that can enter the body and kill tumors without harming surrounding cells.

All this and more may be possible within the next ten years, according to physicist Hal Puthoff, currently with the Institute for Advanced Studies at Austin, Texas. The source of these marvels? Something Puthoff calls zero point energy - the abundant power that he says can be found in the vacuum of space. Puthoff's articles on the subject have been published in the prestigious *Physical Review*. And he has attracted heavy-hitting business associates, including Ken Shoulders, the man credited with developing much of the technology for microcircuits, as well as superrich Texas entrepreneur Bill Church. Rumor has it that their new company, Jupiter Technologies, may soon try to manufacture zero point energy machines. There's more: Zero point energy could be the Rosetta stone of physics, explain everything from gravity to atoms to the origin of the cosmos itself.

In a sense, Puthoff's search for order in the universe started 20 years ago, when he was a freshly minted Ph.D. from Stanford University. One day, the physicist now explains, he was thinking about tachyons, hypothetical particles that appear to travel backward in time. If the particles existed, he reasoned, they might be the "missing link" that allowed psychics -- if they were not frauds -- to intuit events at distant locations or future times. Puthoff sought funding to study the problem and wound up as head of a new parapsychology research program at the Stanford Research Institute, now known as SRI International. Studying telekinesis and ESP was intriguing, Puthoff says. Yet in 1985, after 13 years at SRI, Puthoff was ready to make a change.

Enter Bill Church. An ex-math major from the University of Texas, Church dropped out of college when his father died. By the mid-Eighties, the trim, personable entrepreneur had made millions with a regional chain of friend-chicken restaurants. Eager for new challenges, the energetic Church vowed to spend his wealth promoting the kind of high-risk, potentially high-payoff research that government and corporate bureaucrats were too unimaginative to fund.

Probing the boundaries of physics, a trio of mavericks is tapping the hotbed of force found in vacuum

During the Casimir effect in a vacuum, objects come together, producing enormous heat and energy. Another force to be reconed with: Electronics whiz Ken Shoulders.

If visionary physicist Hal Puthoff is proved right, we may soon have a new, nonpolluting energy source. How? By tapping the force of random fluctuations that jostle atomic particles within a vacuum.

To that end he founded the Institute for Advanced Studies, housed in a two-room office in a new building along the Capital of Texas Highway in Austin. Then he lured Puthoff, also a respected laser scientist, away from SRI.

Soon after Puthoff arrived in Austin, he and Church recruited a third member to their team: star inventor and electronics genius Ken Shoulders. A born tinkerer, Shoulders wanted a new research project, something that would probe the unknown regions at the borders of physics and electronics, where strange and wondrous discoveries might yet be made. He also needed some funding. Puthoff and Church, on the other hand wanted someone who could turn the theoretical work of the institute into nuts-and-bolts technology. When the three sat down to ponder their first project, they came up with an impressive goal: exploring the vacuum, referred to by some early physicists as "the tranquil void."

The institute trio knew that vacuums were not really empty and certainly never tranquil. In fact, most physicists casting their eyes toward the cosmos believe that the vacuum is a hotbed of forces. Phantom particles flicker into existence and then disappear. "Empty" space itself seethes with what physicists call vacuum fluctuations: vast amounts of energy that suddenly burst forth, jiggling particles to and fro. One fluctuation is not very powerful, but cumulatively they can be intense. In fact, physicists John Wheeler and Richard Feynman calculated that there is enough energy in the vacuum of a single light bulb to boil all the seas.

It was City College physicist Timothy Boyer of New York, however, whose work convinced Puthoff that the vacuum was a good place for the institute to begin. Most physicists, Boyer pointed out, tried to explain the somewhat random movements of atomic particles through the theories of quantum physics. Quantum physics states that even under precise conditions, atomic particles may assume any one of a variety of positions. To determine with greater certainty where a particle could be found, however, physicists developed "probability equations." The equations predicted the likelihood of any given particle landing in any given place.

Boyer held a different point of view. Perhaps, he suggested, the uncertain nature of the subatomic realm was due not to the nebulous mathematics of probability equations but rather to vacuum fluctuations. We could not pin down the location of subatomic particles, Boyer suggested, because vacuum fluctuations jiggled them around.

Puthoff felt Boyer's notion could be used to explain other vexing problems as well. Writing in *Physical Review D*, Puthoff suggested that the zero point energy of the vacuum might prevent atoms from collapsing, allowing the world as we know it to be. "According to classical physics," Puthoff says, "electrons should radiate their energy as they circle in their orbits. Eventually

they should drop into the nucleus like a satellite falling back to Earth. Quantum mechanics never really explains why this does not happen.”

Zero point energy does. According to Puthoff’s theory, electrons do radiate their energy away as they circle in their orbits. But they also absorb enough energy from vacuum fluctuations to make up for the loss. Calculations presented in *Physical Review* appear to back him up. Says Puthoff, “It seems that the stability of matter itself depends on the zero point energy sea.”

Puthoff’s next *Physical Review* paper was even more daring. It attempted to rewrite the theory of gravity proposed by Einstein himself. “Einstein described gravity as a warping of space-time caused by the mass of objects within it,” Puthoff says. To understand Einstein’s version, imagine the fabric of space-time as a taut rubber diaphragm. Place any given weight in the diaphragm and it makes an indentation. Roll a marble onto the diaphragm. No matter how the marble is rolled, it ultimately winds up at the weight. This, according to Einstein, is how gravity works. Objects bend space-time just as the weight bends the rubber diaphragm, so two objects “roll together” with a force that depends on the objects’ mass and distance.

“This shows how gravity acts,” Puthoff says, “but doesn’t really explain the mechanism behind it.” That’s where zero point energy comes in. If two physical bodies are relatively close, he theorizes, the first shields the second from zero point energy coming from its direction; in a similar fashion, the second object will shield the first. The objects will nonetheless continue to be pressured by zero point energy coming from all *other* directions. The two bodies thus move toward each other in what scientists have dubbed the Casimir effect, named after Hendrik B. G. Casimir, the Dutch physicist who first described the phenomenon. Gravity is the result, according to Puthoff.

It is the Casimir effect, Puthoff believes, that may help us extract zero point energy from the void. Puthoff gives an example: Bring two smooth metal plates extremely close together, he explains, and they seem to attract each other so strongly that they are virtually welded to each other. Move them still closer and they collide with a metaphorical boom, generating enormous heat. Use that heat energy, and the conversion of vacuum energy to usable energy has occurred.

This scheme, first proposed by veteran California physicist Robert Forward in *Physical Review*, has a problem: Once the plates collide, they can no longer be used to generate energy, becoming a sort of one-shot device. “To recycle the generator,” Puthoff explains, “one would have to return the plates to their original positions; that would require as much energy as the machine produced in the first place. As a result, not even break-even operation could be achieved.”

His solution: "an inexhaustible supply of such devices, each to be discarded after the Casimir collapse." Puthoff concedes this would not be possible with metal plates but suggests that engineers try designing zero point energy machines with a cold, charged plasma, or gas. "The Casimir effect would pinch the plasma together," Puthoff says, "and energy in the form of heat and condensed, charged particles would result."

At least one such device, Puthoff says, may be in the works. Moscow physicist Alexander Chernetsky has built a plasma generator that reportedly takes 700 watts of electricity from a wall socket and gives back 3,500 watts, creating a little more than three horsepower out of nothing. The Soviet government was impressed enough to back his research with several hundred thousand dollars worth of equipment.

"I went to the Soviet Union to look at Chernetsky's work," Puthoff says. "I couldn't tell in a couple of days whether his equipment really works or whether there is some fallacy in his experimental design. But it is plausible that it might be extracting zero point energy."

Whether or not Chernetsky's power system works, other equipment apparently based on zero point energy and the Casimir effect is under development. The inventor: Ken Shoulders, who hopes to create the next generation of circuits for laptop computers, telephones, and large-screen TVs.

Shoulders hopes to create these new appliances through a phenomenon he has discovered and put to use. Called condensed charge technology, or CCT, the phenomenon occurs when electrons crowd together much as in Chernetsky's plasma or Puthoff's metal plates, "When electrons are packed densely enough, they no longer repel each other," says Shoulders. "Instead they form charge clusters that hold together even without a wire to carry them. That lets us build circuits from grooves in a sheet of ceramic or plastic.

Condensed charges can move through these grooves one thousand times faster than electrons travel through a semiconductor chip." What is more, says Shoulders, it's fairly easy to generate condensed charges: Just make a spark.

His first major tick, Shoulders hopes, will be replacing today's silicon computer chips. If anyone else made so unlikely a claim, few would listen. But the sixty-two-year-old Shoulders, formerly of the Massachusetts Institute of Technology and Stanford Research Institute, possesses extraordinary credentials: In the early Sixties, he made the world's first vacuum microelectronic circuits and the very first prototypes of the equipment now used to manufacture silicon chips.

According to Shoulders, his new circuits will render silicon-based technology obsolete. "It looks like there is nothing in electronics that you cannot do a whole lot better with clustered charge," he says.

For an amiable Texan, Shoulders is remarkably closemouthed about the product he is said to be developing. But he is open about the advantages of condensed charge. "Using beads of condensed charge, we have already made transistor-type switches with speeds of less than one trillionth of a second. That's ten thousand times faster than you can buy, and I think we're going to get a lot faster than that," Shoulders says. In fact, engineers working with conventional chips a couple of inches long are having trouble figuring out how to speed the passage of electrons from one side to the next. With condensed charge technology, however, electrons move so rapidly that a single circuit could be a foot across.

Long, compact circuits working at high speed would enable us to build machines with far less bulk than today's technology. For instance, Shoulders says, we could build "a hundred-horse-power motor no bigger than the shaft it takes to deliver the torque [power], or a flat-screen TV with all the electronics built right into the display. You could use the screen for anything from high-definition TV to computing. Simpler yet: an X-ray machine that fits inside a hypodermic needle. You could put it into the patient's body to irradiate a tumor, say, without exposing the other organs to X rays. We already have companies experimenting with these things."

Perhaps most incredible, CCT may be available soon. Condensed charge devices are astonishingly easy to make, Shoulders says. "We can get rid of the complicated photographic techniques I had to invent to make microchips and use simple etching and stamping. This is really low-tech. Any Third World country can do it."

Though Shoulders works closely with Puthoff, he is reluctant to admit that CCT derives from zero point energy for sure. "There are at least four competing theories that might explain condensed charges," he says, "and though zero, point energy is a likely candidate, I can't say which theory will turn out to be right."

Other scientists give Puthoff's work on zero point energy mixed reviews. Timothy Boyer, whose papers inspired Puthoff in the first place, for instance, disagrees with Puthoff's explanation of gravity. "As far as I am concerned, the idea is fuzzy and the calculations ambiguous," Boyer says. "To think in terms of the curvature of space-time is a much more useful, extensive idea."

Physicist Alfonso Rueda of California State University at Long Beach, on the other hand, is sympathetic to Puthoff. Rueda studied vacuum fluctuations, using them to explain both the enormous power of cosmic rays and the dense concentration of stars at certain intersections of the universe. Rueda feels Puthoff has presented some powerful evidence for his idea that zero point energy holds atoms together. And he is "impressed with Puthoff's treatment of gravity. I think he is on the right path."

New York University physicist Benjamin Bederson, editor of the respected *Physical Review A*, where most of Puthoff's work has been published, has an opinion as well. "Many articles that appear in *Physical Review* turn out to be wrong," Bederson says. "Like any journal, we rely on the judgment of our referees. Some expressed doubts about Puthoff's conclusions, but they all agreed that it was stimulating work and deserved a wider audience."

As for Puthoff, he is confident indeed. A new series of experiments, he says, should deal with Boyer's criticisms and move his own research along. Meanwhile he looks forward to the day we tap the power in the void, using it to energize our cities and propel starships beyond the solar system without an ounce of onboard fuel. "Only the future," Puthoff says, "can reveal the ultimate use to which humans will put the remaining fire of the gods, the quantum fluctuations of empty space."

TOM BEARDEN FIGHTS FOR REVOLUTIONARY SCIENCE

BY WILLIAM P EIGLES

ATLANTIS RISING, NUMBER 12

A New Energy Pioneer Lays the Groundwork for Coming Discoveries

Every revolution has its leading theorists, individuals who attempt to construct a logical, coherent formulation of new principles and concepts to rationalize and explain the occurrence of radical, Paradigm-upsetting events or developments. Even if not there at the beginning of such seminal milestones, such individuals are quickly spawned in the aftermath, acting as compelling champions for the activists who are making the history. In the case of the revolution beginning to emerge more publicly in the field of alternative energy sources and technology, retired Army lieutenant colonel Thomas Bearden may soon be recognized as one of a small cadre of scientists and engineers who were just such credible boosters, convinced of and actively supportive of alternate energy realities early on.

Bearden recently delivered a paper on energy flow, collection, anti dissipation in overunity electromagnetic devices at the International Symposium on New Energy in May in Denver, Colorado, where *Atlantis Rising* had a chance to visit with him.

Big, bluff, and indefatigably ebullient in demeanor, Bearden first came to public notice in the early 1980s with the publication of his book *Excalibur Briefing*, in which he offered theoretical explanations for a wide array of paranormal phenomena and discussed various military applications of psychotronic research in the United States and the Soviet Union. One of his many controversial claims was that the U.S. Navy nuclear submarine *Thresher*, which sank in the Atlantic Ocean with all hands on board in mid-1963, was the victim of an advanced operational Soviet psychotronic weapon. Since the early 1990s, however, Bearden has shunned any discussion of psychotronics, mysteriously claiming reticence to be the prudent course for any man interested in "staying healthy." This consideration also impels him to avoid any work on anti-gravity propulsion systems, work he became familiar with in his consulting work in the 1980s for the late inventor Floyd "Sparky" Sweet. It would seem that investigating certain areas of energy research, like the subject of government involvement with UFOs, entails more and greater

risks, for undisclosed but perhaps easily inferable reasons relating to the nature of politico-economic power and those in our world who possess it in great concentration.

What Bearden is voluble about, however, and what occupies his time and attention almost exclusively these days, is his work on perfecting the theoretical scientific underpinnings of, and ultimately a verifiable model for, electromagnetic systems that legitimately produce more energy than they consume (known as "overunity" devices). Such systems propose to make use of the random electromagnetic fluctuations that exist in the vacuum of space, known variously as "free energy," "space energy," or "zero point energy." Armed with an M.S. degree in nuclear engineering from the Georgia Institute of Technology and longtime employment in the aerospace industry, Bearden has researched this topic intensively for over 20 years, and currently serves as president of CTEC, Inc., his own research and development company located in Huntsville, Alabama.

Bearden's work began with a reexamination of the fundamental concepts of classical electrodynamic theory, in light of the teachings of modern quantum mechanics and particle physics, in order to better understand how and why current actually flows in electrical circuits, where that energy comes from, and how it might be increased. This effort suggested to him major flaws in the paradigm established by 19th century scientists James Clerk Maxwell and Hendrik Lorentz, whose equations and calculations (as they are known today) dealt only with the electrical energy that measurably flows in circuits and powers the devices that are attached. Analogizing to the water flowing around a fixed paddle wheel immersed in a river and the moving air surrounding a windmill, Bearden discovered that the free energy of space was knowingly ignored as a useable source of electrical energy by these scientists, and that the classical theory needed updating to reflect 20th century discoveries.

In Bearden's view, the principal faults in reasoning lay in two places. First, the algebra used to express Maxwell's original equations was changed, to ease understanding by others, from the highly complex quaternion type, which allowed and even prescribed overunity electromagnetic systems powered by space energy, to the much simpler tensor vector analysis, which did not. Second, Lorentz mathematically narrowed the scope and application of Maxwell's equations to describe only that part of the energy flow that physical circuits were designed to catch and use. In overall effect, according to Bearden, the early theorists made mistakes in interpreting their own calculations and unwittingly modified their original equations to discard a significant portion of the energy that was extractable -- and, in fact, is extracted -- from the vacuum by actual physical systems. The central issue for him therefore became: How does one redesign these systems in a new way to be able to collect and make effective use of this excess energy from the river of

space, which demonstrably exists and is so readily available in the ambient environment? And then: How does one keep the redesigned systems from destroying themselves by overtapping the infinite energy source of space?

Bearden has posited that an iterative collecting and scattering of space energy could be used to enable a quantum of energy to be reused multiple times, performing a quantum of work in each rescattering. This iterative "retroreflection" and multipass recollection would serve to increase the density of collected energy and therefore the local potential and strength of source dipoles (separations of charges) that occur in space due to the interaction between free charges and the vacuum. Bearden has labeled this process "asymmetric regauging" and believes that it increases the energy extraction by dipoles existing in the vacuum exchange. He believes that this process has been experimentally proven by the Patterson Power Cell[®], an innovative, recently marketed power device with a demonstrated overunity energy output.

Bearden's work progressed to clarifying the nature and characteristics of the two wave components of electromagnetic energy fields, the transverse and the longitudinal waves. Created simultaneously but traveling on different planes, Bearden likens the transverse wave to the easily perceived, slow waveform seen on the ocean's surface and the longitudinal wave to a swift-moving subsurface pressure wave that does not disturb the surface and is not capable of being measured by existing technology. Through the work of researchers Donnelly and Ziolkowski, Bearden found that, by science's current Selection and use of the transverse wave 40 power conventional electrical devices, the hidden longitudinal wave is somehow "killed off," preventing it from being exploited to do useful work. The longitudinal wave, however, is potentially more powerful than the transverse wave, in that the former allegedly moves many times faster than the speed of light, which is a limiting factor for conventional signal transmission using the transverse wave component, because of the theoretical ability of the internal longitudinal wave to facilitate virtually instantaneous signal communication across vast expanses of space, Bearden has focused on how to stimulate and select it for use, and allow the transverse wave to be canceled, or not initially produced, instead.

Bearden notes that he is now preparing a patent application for the initial part of what he terms "a superluminal communications system," that uses a longitudinal wave process and is capable of transmitting signals at speeds faster than the speed of light. He contends that the basic concept has already been shown theoretically and experimentally at microscopic level by other researchers using waveguides. His team specifically intends to show how to form the longitudinal wave, by transmitting a video signal inside a DC voltage without any transverse wave signal accompanying it, and then retrieving the signal without the presence of any noise.

Bearden already has three patents now pending in the field of electric circuits, all of which purport to achieve overunity in energy output with absolute conformance to the conventional laws of physics. Nonetheless, he makes no claim to have yet developed a working model of any overunity device in his own laboratories. He does claim that his experimental results have been encouraging to date, and that, as far back as 1990, his team was blowing up circuits due to the excess space energy they were tapping. The energy apparently could not be controlled in the semiconductor arrays being used at that time, which caused the energy to "ping-pong" back and forth between them until the resulting surge overloaded one of the arrays.

Bearden states, without disclosing more, that his team now knows how to control the energy flow, but is at a standstill for lack of funding. Fabrication difficulties have prevented forward movement on another means of energy now control using a specialized, hard-to-engineer metallic material he has dubbed, with tongue in cheek, "Unattainium." However, he allows that his work in using multiple passes of energy, collecting it repeatedly using retro-reflection in electric circuits and thus enabling increased energy extraction, holds the most promise.

Bearden's work in this last vein may owe its stimulus to his consulting assistance to home inventor "Sparky" Sweet in the 1980s. Sweet had invented an assembly of wire coils and barium ferrite magnets that would extract energy from space and produce six watts of usable power, with only a much smaller trickle of energy as input. Dubbed a "vacuum triode amplifier" (VTA) by Bearden, a later model reportedly produced 500 watts of output power, showing a net gain of 1.5 million over the input power level. Bearden theorized that Sweet's device "tricked" the barium nuclei of the magnets into going into self-oscillation with the ambient vacuum, causing the fields of the specially conditioned "kinetic" magnets to quiver at a high level. The theorist prevailed upon Sweet to make a change in his device that would allow for a test of anti-gravity properties. Sweet later reported to Bearden by phone that, by increasing the power output drawn from his device by adding greater loads, he was able to reduce the weight of the VTA, as measured by a scale, by 90 percent. Concern about the likelihood of exploding the magnets prevented Sweet from reducing the VTA's weight entirely and seeing it fly. Unfortunately, all of Sweet's secrets about how to activate his magnets to achieve his startling results died with him in 1995, and Bearden was left to pursue his theoretical research without the benefit of a working model.

At this time, the theorist is working on two books. One of them, due out next year, will present "the world's first legitimate theory of overunity electromagnentic engines, circuits, and devices," according to Bearden, and will contain "a little necessary secret" essential to building them. The other book is expected to be published later this year, and deals with Bearden's

second and related main interest, the "Priore device" that was developed under the aegis of the French government in the 1960s and early 1970s.

Bearden reports that the Priore device is reputed to have cured terminal tumors in laboratory animals, and is able to cure any disease, including arteriosclerosis and cancer, by a special electrodynamic process known as "phase conjugation" or "dedifferentiation." This process, seemingly miraculously, allegedly causes afflicted cells to return to their previously healthy state by literally turning back the clock on the disease. Bearden states that this process is a direct outgrowth of the work of American Nobel Prize nominee Dr Robert Becker, who demonstrated the use of small DC currents to heal intractable bone fractures by stimulating the growth of new bone. The trickle current apparently caused red corpuscles to shed their hemoglobin coating, grow new nuclei, and metamorphose into a much earlier, primitive version of the cells before differentiation. These cells could then be newly differentiated into needed bone cells, which would deposit themselves at the fracture point and result in a knitting of the broken bone. It is this basic process that Bearden asserts can be imported into the treatment of infectious and terminal diseases, including the restoration to health of the immune systems of people with AIDS. And, Bearden claims, the Priore mechanism can effectuate healing in a matter of minutes.

Looking to the future of overunity electromagnetic systems, Bearden sees the greatest obstacle to their realization being the mindset of the existing research-funding establishment and the orthodox scientific community that it serves. The flow of funding effectively controls what research is pursued by scientists working at universities and in industry. And it is the mindset against the possibility of tapping and collecting space energy to provide useable electricity that serves to block the allocation of money to develop working prototypes. The early new energy pioneers that have most influenced Bearden in his own efforts, Nikola Tesla and T. Henry Moray, faced this same mindset, resulting in their work being ignored by the scientific community of their time and eventually being suppressed by various contemporary interest.

Still, Bearden remains optimistic. He believes that once a scientifically verifiable model is perfected that is consistent with modern particle physics and thermodynamics and working, experimental proof is clearly established -- thereby dispelling any notions that perpetual motion is being proposed -- the mainstream scientific community will begin to lend support and the rate to a new energy future will be on in a big way. He foresees commercially marketed overunity devices becoming available in two years, with homes and cars later being powered by insertable solid-state, energy-collecting cards. And, with the advent of the Internet, the ubiquitous availability of modern communications links, and the proliferation of journals and newsletters dedicated to alternate energy technology, the ability of a hostile establishment

to suppress scientific innovation and its proponents is now greatly reduced. The new-energy genie, once out, will be much tougher to get back into the bottle than in earlier decades.

For his part, Bearden believes that his major contribution will be to "have blown a hole in the brick wall, not a nice door," of the traditional way of thinking about overunity systems, primarily as a theorist rather than an inventor. He expects that interested, bright graduate students and post-doctoral fellows will take matters to the next level. Only time will tell. Although Bearden is not without his detractors, he is an undeniably engaging and colorful character whose deep conviction about his work and its results inspires both fascination and curiosity. If, in conversing with him, you were to evince any doubt about his claims, Bearden is quick to point out, "This is not Tom Bearden [talking], it's in the [scientific] literature! If only people would read it and test it." Agree with him or no, he is, in the very least, a visionary of almost evangelical fervor who is sincerely dedicated to helping develop a new source of useable energy that is cleaner, cheaper, safer for the earth and its peoples, and universally available worldwide. To be sure, that's a goal worthy of everybody's attention.

THE LEFTOVERS OF NOTHING

THE ECONOMIST, JULY 1, 1989

NOTHINGS ain't what they used to be. By using his air pump -- one of the high points of seventeenth-century technology -- to remove all the air from a cavity, Sir Robert Boyle made it clear to restoration England what a vacuum was. It was what was left when you took everything away: emptiness. In the early twentieth century, quantum mechanics made everything more complicated. A vacuum is still what is left over when everything is taken away; but that no longer means that it is emptiness. The non-empty vacuum plays a fundamental role in the way physicists think about matter.

Descendants of Boyle's air pump now produce vacuums that are, to all intents and purposes, completely free of matter. But they can never be completely free of energy. According to quantum theory, it is impossible to remove all the energy from any system. As in a tin of sardines, there is always a little bit in the corner that you cannot get out. The magnitude of this "zero-point energy" is tiny; as far as everyday uses go, it can be ignored. Nobody can measure the zero-point jiggling of a pendulum caused by the mote of energy remaining in the system when nothing else is left. But not all such effects are negligible. Electromagnetic fields also have zero-point energies. In the vacuum, every electromagnetic mode--that is, every way in which an electromagnetic field could vibrate, if there was one there--has its zero-point energy. The energy for each mode is tiny, but there are an awful lot of modes. Adding them together reveals a vacuum crammed with energy.

It is surprisingly hard to find evidence of this sea of energy--largely because the level of the energy is the lowest that can be reached. There is no lower level with which it can be compared. Like sea-level for land maps, the vacuum energy is the reference point above which all else is measured. Zero-point effects do turn up, though, when matter and vacuum interact. The first to be recorded was the atomic Lamb shift. Atoms are surrounded by electrons which can have various different levels of energy. When an electron moves from a higher level to a lower one, it emits a burst of light at a particular wavelength: a photon. The wavelength can be predicted precisely from theory. In some cases, though, the wavelength observed is different from that predicted. The difference turns out to be exactly what one would expect from the effects of lots of tiny electromagnetic fields working on the electrons--the effect of the vacuum field.

Not only is the wavelength of the photon dependent on vacuum effects, so is the fact that it appeared at all. There are two ways for an electron

to unburden itself of a photon and come down from a higher energy level. If the electron is hit by a photon of the right wavelength, it will be knocked down, and there will be two photons where there was one before. That is stimulated emission, the principle behind the laser. Alternatively you can wait for the electron to jump down on its own, giving up its photon by spontaneous emission. When the vacuum energy is taken into account, the distinction between these two breaks down. Spontaneous emission can be seen as stimulated emission, with the zero-point energy of the vacuum providing the stimulation. So the emission of light does not depend just on the atom-it depends on the way that the atom and the vacuum interact. By changing the vacuum, you can change the way the atom emits light.

A vacuum between two sheets of metal is not the same as one that is unconstrained. Some of the modes of the electromagnetic field are suppressed--the modes which represent waves in the field that are too big to fit into the cavity. By changing the size of the cavity, you can lose certain modes. Groups of scientists around the world have built cavities that rule out certain modes of vacuum energy, and thus stop atoms from emitting photons at various wavelengths. Using a related technique, they have designed and built cavities that enhance the radiation by allowing the atom to "see" more modes of the vacuum radiation than it would if there was no cavity. The results of such experiments allow scientists to explore otherwise inaccessible areas of quantum electrodynamics, the theory of electromagnetic fields.

An intriguing theoretical point about the way that atoms interact with vacuum has been made by Dr Hal Puthoff of the Institute for Advanced Studies in Austin, Texas. For every atom there is an energy level below which the electrons cannot sink. Dr Puthoff suggests that this is because, at the low energy levels, electrons cannot lose energy any faster than they pick it up from a vacuum. It is the vacuum energy that buoys them up, stopping them from losing all their energy and collapsing into the atomic nucleus. That means that the vacuum underpins the stability of every atom--and thus of almost all matter in the universe.

Force from nowhere

Vacuum zero-point energies can explain effects on a larger scale as well. The vacuum energy exerts a pressure on everything. Normally, this pressure has little effect, since it comes from all directions at once and almost cancels out. But if two atoms are reasonably close to each other, each will shield the other from some of the pressure. There will be slightly less pressure FROM the direction of the neighbouring atom than there is from every other direction--so the atoms will tend to move together.

This is the Van der Waals force. Though it is weak, it is strong enough to hold atoms and molecules together in gases and liquids. There are other ways to describe Van der Waals forces, in terms of the way the electrons jitter around the atoms, but they also depend on the vacuum; they just come at it in a different way.

An analogous force can be measured between parallel metal plates which are placed close together--say a few thousandths of a millimetre apart. Because the distance between the plates limits the wavelengths available for the zero-point energy, there are fewer modes available in the vacuum between the plates than in the vacuum outside. So the pressure from outside is greater, and becomes greater still as the plates are pulled together and yet more modes are ruled out. This "Casimir effect" may prove an obstacle for people who want to build machinery ever smaller, since it will tend to stick surfaces together.

On the other hand, it may be an opportunity. Dr Robert Forward, a physicist who is always ready to speculate on the outlandish--from antimatter-driven spaceships to life on the surfaces of collapsed stars--has suggested a simple, impractical machine that could remove energy from the vacuum using the Casimir effect. It is farfetched, but getting the Casimir effect to do useful work by holding things together is theoretically possible.

There are further reaches to vacuum energy ideas which are controversial, but still intriguing. Over many years, Dr Timothy Boyer of the City University of New York has tried to show that many of the results of quantum physics can be achieved using none of its assumptions, provided that zero-point energy is allowed. Dr Puthoff has recently revived an idea mooted by Dr Andrei Sakharov in the 1960s that gravity itself can be explained by vacuum effects, more or less as a very long-range version of the Van der Waals force between atoms and molecules. That goes against the grain of modern theory, but some broad-minded colleagues see it as an intriguing speculation.

And there is the question of the other sorts of energy in the vacuum. Interest has focused on the residual electromagnetic fields because there is a successful theory with which to discuss them. But there are other types of field--those associated with the nuclear forces--that are less well known. The way that quarks are bundled together in nuclei may have to do with vacuum pressure. There may still be a lot of mileage for physicists in thinking about nothing at all.

THE ENERGETIC VACUUM: IMPLICATIONS FOR ENERGY RESEARCH

BY H.E. PUTHOFF

"The existence of an actual vacuum was a subject of debate among scientists from Aristotle into the twentieth century. Since light, magnetic fields and heat all travel through a vacuum, something must be there. Borrowing a word from Aristotle, scientists described various kinds of 'aethers' that exist in even the hardest vacuum and that pervade space. Maxwell's theory of electromagnetism reduced these different types to just one, called the ether. Various experiments were developed to detect this ether, of which the most famous was the Michelson-Morley experiment, which failed to find it. Finally, in 1905, Einstein banished the ether by means of special relativity and allowed the true vacuum to exist.

"But not for long. The Heisenberg uncertainty principle of 1927 led particle physicists to predict that particles would arise spontaneously from the vacuum, so long as they disappeared before violating the uncertainty principle. The quantum vacuum is a very active place, with all sorts of particles appearing and disappearing. Careful experiments have demonstrated that the quantum theorists are correct in this interpretation of the vacuum... Furthermore, starting in 1980 with the theory of the inflationary universe, particle physicists have told us that the entire universe was created as a 'false vacuum', a quantum vacuum that has more energy in its nothingness than it should. The decay of that particular vacuum to an ordinary quantum vacuum produced all the mass in the universe and started the Big Bang."

From "The Timetables of Science", Simon and Schuster, 1988

Introduction

Modern physical theory, specifically quantum electrodynamics (QED), tells us that the vacuum can no longer be considered a void. This is due to the fact that, even in the absence of matter, the vacuum is neither truly particle nor field free, but is the seat of virtual particle-pair (e.g. electron-positron) creation and annihilation processes, as well as zero-point-fluctuation (ZPF) of such fields as the vacuum electromagnetic field, which will be the focus of our study here.

Formally, the energy density associated with the vacuum electromagnetic ZPF background is considered to be infinite. With appropriate high-frequency cutoffs the ZPF energy density is still

conservatively estimated to be on the order of nuclear energy densities or greater.[1] The enormity of the figures describing the vacuum electromagnetic zero-point energy raises the question as to whether these numbers should be taken seriously, whether they are due to some defect or misinterpretation of the theory, whether the ZPF fields ought to be considered as 'virtual' or 'real'.[2] There is, however, no question but that the ZPF fields lead to real, measurable physical consequences. One example is the very real Casimir force,[3-6] an experimentally-verified [7-9] ZPF-induced attractive quantum force between closely-spaced metal or dielectric plates. An elegant analysis by Milonni, et al., at Los Alamos National Laboratory shows that the Casimir force is due to radiation pressure from the background electromagnetic zero-point energy which has become unbalanced due to the presence of the plates, and which results in the plates being pushed together.[10] (We will discuss this effect in more detail later when we address the possibility of ZPF energy extraction.) Other effects which can be traced back to interactions involving the ZPF fields in a fundamental way include the Lamb shift (the slight perturbation of the emission lines seen from transitions between atomic states),[11-13] the van der Waals chemical binding forces,[14] the stabilization of atomic structure against radiative collapse,[15-16] quantum field mechanisms underlying the gravitational interaction,[17] and spontaneous emission.[18]

Zero-Point Energy

To understand just what the significance of zero-point energy is, let us begin with a simple harmonic oscillator as shown in Figure 1. According to classical theory, such a harmonic oscillator, once excited but with excitation removed, will come to rest (because of friction losses) as shown in Figure 1(a). In quantum theory, however, this is not the case. Instead, such an oscillator will always retain a finite amount of 'jiggle', as shown in Figure 1(b). The average energy (kinetic plus potential) associated with this residuum of motion, the so-called zero-point energy, is given by: $\langle E \rangle = \frac{1}{2} \hbar \omega$, where 'h' is Planck's constant ($h = 6.626 \times 10^{-34}$ joule/sec) and 'w' [really 'omega'] is the frequency of oscillation. The meaning of the adjective 'zero-point' is that such motion exists even at a temperature of absolute zero where no thermal agitation effects remain. Similarly, if a cavity electromagnetic mode is excited and then left to decay, as shown in Figure 2, the field energy dies away, again to a minimum value $\langle E \rangle = \frac{1}{2} \hbar \omega$ (half a photon's worth), indicating that fields as well as mechanical systems are subject to zero-point fluctuations. It is the presence of such ZPF 'noise' that can never be gotten rid of, no matter how perfect the technology, that sets a lower limit on the detectability of electromagnetic signals.

If we now consider the universe as a whole as constituting a giant cavity, then we approach a continuum of possible modes (frequencies, directions) of propagation of electromagnetic waves. Again, even in the absence of overt excitation, quantum theory has us assign an $\langle E \rangle = \hbar\omega/2$ to each mode. Multiplication of this energy by a density of modes factor [19] then yields an expression for the spectral energy density that characterizes the vacuum electromagnetic zero-point energy

$$\rho(\omega)d\omega = [\omega^2/\pi^2c^3]/[\hbar\omega/2]d\omega = (\hbar\omega^3)/(2\pi^2c^3)d\omega \text{ joules/m}^3$$

(eqn. 1)

There are a number of properties of the zero-point energy distribution given in equation 1 that are worthy of note. First, the frequency behavior is seen to diverge as ω^3 . In the absence of a high-frequency cutoff this would imply an infinite energy density. (This is the source of such statements regarding a purely formal theory.) As discussed by Feynman and Hibbs, however, we have no evidence that QED remains valid at asymptotically high frequencies (vanishingly small wavelengths).[1] Therefore, we are justified in assuming a high-frequency cutoff, and arguments based on the requirements of general relativity place this cutoff near the Planck frequency ($\sim 10^{43}$ cm).[17] Even with this cutoff the mass-density equivalent of the vacuum ZPF fields is still on the order of 10^{94} g/cm³. This caused Wheeler to remark that "elementary particles represent a percentage-wise almost completely negligible change in the locally violent conditions that characterize the vacuum...In other words, elementary particles do not form a really basic starting point for the description of nature. Instead, they represent a first-order correction to vacuum physics." [20] As high as this value is, one might think that the vacuum energy would be easy to observe. Although this is true in a certain sense (it is the source of quantum noise), by and large the homogeneity and isotropy (uniformity) of the ZPF distribution prevent naive observation, and only departures from uniformity yield overtly observable effects.

Contributing to the lack of direct observability is a second feature of the ZPF spectrum; namely, its Lorentz invariance. Whereas motion through all other radiation fields, random or otherwise, can be detected by Doppler-shift phenomena, the ZPF spectrum with its cubic frequency dependence is unique in that detailed cancellation of Doppler shifts with velocity changes leaves the spectrum unchanged. (Indeed, one can derive the ZPF spectrum to within a scale factor by simply postulating a Lorentz-invariant random radiation field. [21,22]) Thus, although any particular component may Doppler shift as a result of motion, another component Doppler shifts to take its place. It is also the case, again unique to the ZPF cubic-frequency-dependent spectrum, that Doppler shifts due to other phenomena (e.g., cosmological expansion, gravitation) also do not alter the spectrum. [23] This stands in

contrast to, for example, the 3 K blackbody (thermal) microwave background left over from the Big Bang which cools with cosmological expansion.

Yet another feature of the ZPF spectrum, related to its Lorentz invariance and again unique in comparison with all other competitors, is the complete lack of a drag force on a charged particle passing through it. This is because such a drag force (the so-called Einstein-Hopf drag [24]) is proportional to the factor $[\rho(\omega) - (\omega/3)(d\rho/d\omega)]$, and this vanishes identically for $\rho(\omega) \sim \omega^3$.

On the other hand, accelerated motion through the vacuum can in principle reveal the presence of the ZPF energy density directly. Unlike uniform motion in which delicate cancellations of Doppler shifts leave the motion undetected, in accelerated motion the Doppler-shift cancellations are no longer sustained. As a result, the Lorentz-invariant spectrum which holds in uniform motion is augmented by additional terms. One factor yields a thermal (Planck) spectrum of temperature $T = \hbar a / 2\pi c k$, where 'a' is acceleration, 'k' is Boltzmann's constant and 'T' is temperature. This is known as the Davies-Unruh effect. [25,26] Yet another factor which shows up in the ZPF spectrum of an accelerated observer is found, via the equivalence principle, to reveal a deep connection between zero-point energy and gravity along lines originally proposed by Sakharov [27] (that gravity could be understood as an induced effect brought about by changes in the quantum fluctuation energy of the vacuum due to the presence of matter [17]).

Thus we see that, with its roots in relativity theory which banished the ether, QED has in some sense come full circle to provide us with a model of an energetic vacuum that once again constitutes a plenum rather than a void.

Source Of Zero-Point Energy

The fact that the vacuum constitutes an energy reservoir leads naturally to the question as to where the zero-point energy comes from, specifically, the vacuum electromagnetic zero-point energy under discussion here. (This is an especially important issue if one considers the possibility of extracting such energy for use.) Nature provides us with but two alternatives: existence by fiat as part of the boundary conditions of the present universe (like, for example, the 3 K cosmic background radiation left over from the Big Bang), or generation by the (quantum fluctuation) motion of charged particles that constitute matter. This latter possibility was explored in a recent paper by the author, with positive results.[23]

The argument goes as follows. Given charged particles in quantum zero-point motion throughout the universe, a $1/r^2$ dependence of the radiation from such motion, and an average volume distribution of such particles in spherical shells about any given point that is proportional to the area of the

shell (that is, proportional to r^2), one could reasonably expect to find at any given point a sum of contributions from the surrounding shells that yielded a high-density radiation field. (Recall a similar argument in astronomy associated with Olbers' paradox.) The high-density ZPF fields would appear to be just such a field.

The details of the calculations examine the possibility that ZPF fields drive particle motion, and that the sum of particle motions throughout the universe in turn generates the ZPF fields, in the form of a self-regenerating cosmological feedback cycle not unlike a cat chasing its own tail. This self-consistent field approach, carried out assuming inflationary cosmology, is found to yield the correct frequency distribution and the correct order of magnitude to match the known ZPF distribution, thus supporting the hypothesis that the ZPF fields are dynamically generated.

As it turns out, there is an additional bonus from the calculations. A derived expression relating the zero-point energy density to such factors as the mass density and size of the universe also yields a precise expression for an observed 'cosmological coincidence' often discussed in the context of Dirac's large-numbers hypothesis: namely, that the electromagnetic-to-gravitational force ratio between an electron and proton is equal to the ratio of the Hubble distance to the size of the classical electron. According to the relevant calculations such a cosmological coincidence is seen to be a consequence of the cosmologically-based ZPF-generation mechanism under consideration that serves to link cosmological and atomic parameters.

The overall picture that emerges, then, is that the electromagnetic ZPF spectrum is generated by the motion of charged particles throughout the universe which are themselves undergoing ZPF-induced motion, in a kind of self-regenerating grand ground state of the universe. In contrast to other particle-field interactions, the ZPF interaction constitutes an underlying, stable 'bottom-rung' vacuum state that decays no further but reproduces itself on a dynamic-generation basis. In such terms it is possible to explicate on a rational basis the observed presence of vacuum zero-point energy.

Vacuum Energy Extraction?

As we have seen, the vacuum constitutes an extremely energetic physical state. Nonetheless, it is a giant step to consider the possibility that vacuum energy can be 'mined' for practical use. To begin, without careful thought as to the role that the vacuum plays in particle-vacuum interactions, it would only be natural to assume that any attempt to extract energy from the vacuum might somehow violate energy conservation laws or thermodynamic constraints (as in misguided attempts to extract energy from a heat bath

under equilibrium conditions). As we shall see, however, this is not quite the case.

The premier example for considering the possibility of extracting energy from the vacuum has already appeared in the literature in a paper by R.L. Forward entitled "Extraction of Electrical Energy From the Vacuum..."[28]; it is the Casimir effect. Let us examine carefully this ZPF-driven phenomenon.

With parallel, non-charged conducting plates set a distance D apart, only those (electromagnetic) modes which satisfy the plate boundary conditions (vanishing tangential electric field) are permitted to exist. In the interior space this constrains the modes to a discrete set of wavelengths for which an integer number of half-wavelengths just spans the distance D (see Figure 3). In particular, no mode for which a half-wavelength is greater than D can fit; as a result, all longer-wavelength modes are excluded, since for these wavelengths the pair of plates constitutes a cavity below cutoff. The constraints for modes exterior to the plates, on the other hand, are much less restrictive due to the larger spaces involved. Therefore, the number of viable modes exterior is greater than that interior. Since such modes, even in vacuum state, carry energy and momentum, the radiation pressure inward overbalances that outward, and detailed calculation shows that the plates are pushed together with a force that varies as $1/D^4$, viz,[10]

$$F/A = -(\pi^2/240)(\hbar c/D^4) \text{ newtons/m}^2 \quad (\text{eqn. 2})$$

The associated attractive potential energy (Casimir energy) varies as $1/D^3$, $U/A = -(\pi^2/720)(\hbar c/D^3) \text{ joules/m}^2 \quad (\text{eqn. 3})$

As is always the case, bodies in an attractive potential, free to move, will do so, and in this case the plates will move toward each other. The conservation of energy dictates that in this process potential energy is converted to some other form, in this case the kinetic energy of motion. When the plates finally collide, the kinetic energy is then transformed into heat. (The overall process is essentially identical to the conversion of gravitational potential energy into heat by an object that falls to the ground.) Since in this case the Casimir energy derives from the vacuum, the process constitutes the conversion of vacuum energy into heat, and is no more mysterious than in the analogous gravitational case.

In such fashion we see that the conversion of vacuum energy into heat, rather than violating the conservation of energy, is in fact required by it. And this conversion can be traced microjoule by microjoule as modes (and their corresponding zero-point energies) are eliminated by the shrinking separation of the plates. What takes getting used to conceptually is that the vacuum state does not have a fixed energy value, but changes with boundary conditions. In this case vacuum-plus-plates-far-apart is a higher energy state than vacuum-plus-plates-close-together, and the combined system will

decay from the higher-energy state to the lower, in the process creating kinetic energy, then heat, to conserve overall energy. Similar vacuum-decay processes have been discussed within the context of so-called charged vacuum states.[29]

With regard to extracting zero-point energy for use, in Forward's proposed embodiment the two plates in a Casimir experiment are charged with the same-sign charge (e.g., electrons). At sufficiently small spacings the Coulomb repulsion between the plates (which goes in an inverse square law $1/D^2$ or less, depending on spacing and geometry) can always be overcome by the stronger $1/D^4$ attractive Casimir force. The plates will therefore be drawn together in a collapsing motion. This confines the charge distribution to a smaller and smaller volume and results in an increased electric field strength in the vicinity of the plates. In such fashion the zero-point energy (Casimir energy) is transformed into stored Coulomb energy, which can then be extracted by a variety of means.

Although demonstrating in principle the extraction of energy from the vacuum, Forward's embodiment is admittedly impractical for significant, continuous energy generation, for a number of reasons. First and foremost is the fact that the generator is a 'one-shot' device. To recycle the generator one must put as much energy into the device to return the plates to their original separated positions as was obtained during the collapse phase, as would be expected in any conservative potential. As a result, given the losses in any real system, not even 'break-even' operation can be achieved, let alone net energy gain.

Let us carry this one step further, however. If one could arrange to have an inexhaustible supply of such devices, and if it took less energy to make each device than was obtained from the Casimir-collapse process, and if the devices were discarded after use rather than recycled, then one could envision the conversion of vacuum energy to use with a net positive yield. Although almost certainly not achievable in terms of mechanical devices, a possible candidate for exploitation along such lines would be the generation of a cold, dense, non-neutral (charged) plasma in which charge condensation takes place not on the basis of charged plates being drawn together, but on the basis of a Casimir pinch effect. (Casimir pinch effects have been explored in the literature, not with regard to energy conversion, but in terms of semiclassical modelling of charge confinement in elementary particles, hadron bag models, etc.[30])

Such an approach would constitute a 'Casimir-fusion' process, which in its cycle of operation would mimic the nuclear-fusion process. It would begin, like its nuclear counterpart, with an initial energy input into a plasma to overcome a Coulomb barrier, followed by a condensation of charged particles drawn together by a strong, short-range attractive potential (in this

case a Casimir rather than a nuclear potential), and with an accompanying energy release. Should the energy requirements for plasma formation, and electrical circuit and heat losses be kept at a level below that required for break-even operation, then net, useful energy could in principle be generated, as in the nuclear case. Such a proposal is, of course, highly speculative at this point, and further detailed analysis of the energetics involved may yet uncover some hidden flaw in the concept. Nonetheless, known to this author are programs in the United States, the Soviet Union and other countries to explore just such an approach on an experimental basis.

The above provides just one example of the type of concept that can be explored with regard to possible vacuum energy extraction. Other proposals for extracting vacuum energy have been made as well,[31] covering the gamut from the clearly unworkable to the intriguing. To this author's way of thinking, however, there is as yet neither clear-cut evidence of experimental success nor an absolutely unimpeachable theoretical construct. Nonetheless, it is only by continued, careful consideration of such proposals that we can hope to resolve the issue as to whether energy can be extracted from the vacuum, as part of a generalized 'vacuum engineering' concept of the type suggested by Nobel Laureate T.D. Lee.[32] As a caution along the way, the prudent scientist, while generally keeping an open mind as to the possibility of vacuum energy extraction, must of course approach any particular device claim or theoretical proposal with the utmost rigor with regard to verification and validation.

Can the energy crisis be solved by harnessing the energies of the zero-point sea? In the final analysis, given our relative ignorance at this point we must of necessity fall back on a quote given by Podolny [33] when contemplating this same issue. "It would be just as presumptuous to deny the feasibility of useful application as it would be irresponsible to guarantee such application." Only the future can reveal whether a program to extract energy from the vacuum will meet with success.

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2. See, for example, the Closing Remarks section in Boyer, T.H., Phys. Rev. D, volume 29, p. 1089, 1984. It can be added that, although the approach developed here involves treating the ZPF fields as real, an alternative viewpoint can be taken in which the results of field-particle interactions traditionally attributed to ZPF are expressed instead in terms of the radiation reaction of the particles involved, without explicit reference to the ZPF. For this viewpoint, see Milonni, P.W., Phys. Rev. A, volume 25, p. 1315, 1982. Although it is sometimes assumed that the radiation-reaction approach might imply that the ZPF fields do not exist, detailed analysis (see Milonni's paper) shows that even though the interpretation of ZPF effects "can be given exclusively in terms of either radiation reaction or the zero-point field, *both fields are in fact necessary for the formal consistency of the theory*." The interrelationship between these two approaches (ZPF, radiation reaction) can be shown to be complementary on the basis of an underlying fluctuation-dissipation theorem.

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QUANTUM FLUCTUATIONS CREATE SILENT UPROAR IN SPACE

ZERO POINT ENERGY WOULD SOLVE MANY PROBLEMS OF PHYSICS AT ONE STROKE

BY MICHAEL ODENWALD IN VEREIN DEUTSCHER
INGENIEURE, DUSSELDORF JULY 19, 1991

Abstract

It sounds like a fable: heaters heat and automobiles roll and create not a gram of pollution driven by a mysterious energy. This same power will make laptop computers more powerful than today's super computers and will revolutionize other technologies. The fantastic thing here is: this super energy which is supposed to do all these things originates in empty space.

Article

US researchers Harold Puthoff, Ken Shoulders and Bill Church from the Institute of Advanced Studies in Austin, Texas forecast this utopia. The basis of their ideas is vacuum energy, a power which fills the entire universe and probably underlies all material existence. If the theories of the three researchers prove out they would eliminate all worries about energy forever. They would also solve some of the greatest puzzles of cosmology and particle physics including the question of the nature of gravitation.

In the telescopes of the astronomers the universe appears majestically quiet and empty, only spotted here and there by massive world islands. Quantum theory, on the other hand, shows a different, much more bizarre view of the cosmos. It deals with the microcosm of subatomic particles. At the level of particles, like electrons, protons and neutrons, space is not empty, but a boiling sea of energy that fills the space between atoms and molecules as well as between the stars. Particles jump like spray in a foaming ocean, like lightning leaping out of an insubstantive energy bath into the material world. With equal rapidity these particles fall back into the sea of energy and disappear (physicists speak of "virtual particles", because they have no existence in the world of real particles). In this minute instant of their existence, these ghost particles send out a weak pulse of

electromagnetic waves. To be sure, the radiation from individual particles dissipates in an extremely short distance. But because these elements of radiation are generated constantly and everywhere, space is filled by an enormous amount of energy.

The energy density of the vacuum exceeds that in the nucleus of an atom. The American physicists John Wheeler and Richard Feynman have calculated that the energy in the vacuum of a single light bulb is sufficient to bring all the water in the oceans of the world to the boiling point. At the same time this tremendous energy cannot be felt. The reason: it permeates the universe equally in all directions. Thus, matter is held in balance between equal forces.

Nevertheless, this vacuum energy leaves its trace in certain physical phenomena. According to classical physics, every oscillator, like a pendulum, eventually comes to rest because of friction. Quantum theory, on the other hand, states that an oscillator never comes completely to rest, but will continue to oscillate in microscopically small random motions around its rest point, even when it has been cooled to absolute zero so that molecular heat motion is not a consideration. Cause of the unpredictable vibration is the so-called zero point energy.

The source of the vibrations, in turn, are the energetic fluctuations of the vacuum. These provide the virtual particles with their electromagnetic radiations. Particles that are embedded in this ocean of radiation are caused to tremble by the constant impacts of the virtual particles. (This trembling has serious consequences in many physical systems. For example, the unavoidable noise of a microwave receiver. Even the most perfect cannot suppress this noise, since it is caused by the zero point energy that creates the radiations in this wavelength.)

As early as 1940, US physicist William Lamb discovered that fluctuations of the electromagnetic field can easily disturb the paths of electrons around the atomic nucleus. This results in the "Lamb displacement" (photons that are created by the shifting of electrons into a different path show a frequency displaced from the normal value.)

The simple fact that an electron orbits the atomic nucleus on a stable path is a great puzzle of physics. Classical theory describes the atom like a small planetary system: electron planets orbit the sun of the atomic nucleus. Electromagnetic fields work on charged particles. The particles are forced out of their path and react by radiating light. The photons (light particles) carry off the energy picked up from the electromagnetic field. One would therefore expect electrons which are forced into their orbital paths by the nucleus charge, to send out radiations and fall in a spiral path into the nucleus like a satellite falling to earth. Quantum theory does not explain why this

does not happen. It describes the characteristics of the particles and declares that they only jump back and forth between specific energy levels in the electron orbits. Since they cannot drop below the lowest energy level, they do not fall into the nucleus. Even the quantizing of the electron paths does not explain the physical background for their stability.

Harold Puthoff, physicist at the Texas think tank, believes he has the answer: again he sees the ZPE at work. According to his idea, electrons do radiate energy while orbiting the atomic nucleus, but they absorb an equal amount of energy from the electron fluctuations, and so the atom is saved from collapse. Writing in the New Scientist, Puthoff said, "The equilibrium between these two processes leads to the values for the parameters which define the fundamental energy condition. Therefore there exists a dynamic equilibrium in which the zero point energy stabilizes the electron in the its orbital condition. It appears that the stability of matter itself depends upon the fundamental ocean of the electromagnetic fluctuations."

Also, Heisenberg's Uncertainty Principle appears in a new light. This principles states that it is impossible to determine all the conditions of a physical system at the same time, for example, the position and velocity of a particle. If the velocity of an electron is determined, its position remains unclear: although a discrete particle, it appears smeared over a larger area. Only statistics helped quantum physicists out of their dilemma. This makes it possible at least to calculate the probability with which a particle with a certain energy can be found in a certain position. For a long time this indeterminacy was considered a characteristic of matter itself. Actually, it is the ZPE which causes the particles to tremble. Their exact position must therefore necessarily appear unclear, says Puthoff. The uncertainty principle is therefore a direct effect of vacuum fluctuations.

Puthoff even has a new slant on gravitational theory. Einstein saw gravity as a warping of space caused by the mass of objects in space. Galaxies, stars, and planets cause depressions in 4 dimensional space, like marbles on a taughtly stretched rubber surface. If the marbles approach each other, they roll in the direction of the indentations caused by their weight. "This shows how gravity functions, but it doesn't explain the mechanism behind it," says the US physicist. Again, Puthoff's famous theory, as written up in the Physical Review, sees the power of the vacuum at work. As two bodies approach each other one will screen off the second from the radiation field of the ZPE coming from it's direction. And vice versa. Out of all the other directions these bodies continue under the influence of the pressure of the fluctuations. The result: they move toward one another.

It now appears no longer necessary to unite gravitation in an all encompassing theory with the other three fundamental powers of nature - the electromagnetic as well as the strong and weak nuclear forces. The creation of a unified field theory has hitherto caused physicists tremendous difficulties. Although the theory of electromagnetic fields could be tied to radioactive decay and the power that holds the atomic nucleus together, gravity did not fit into any of the mathematical concepts which grew into increasingly abstract Babylonian towers of physics, and were consequently unsuccessful.

As a result of the ZPE, gravitation is not seen to be a fundamental power but is only a secondary effect, resulting from the alternating functioning of other fields. In this form gravity is already a component of the unified field theory. At the same time it becomes clear why gravity is so weak, always pushing and never pulling and -in contrast with electromagnetic fields - it cannot be shielded: vacuum fluctuations penetrate space itself. The recently deceased Russian physicist, Andrei Sakarov, also saw gravitation as a result of the inter-workings of the vacuum energy and matter. This should make it possible to calculate the value of the gravitational constant G by parameters derived from the theory of ZPE. Puthoff followed Sakarov's ideas with some success. So particles that are coupled through vacuum fluctuation fields experience an attractive force on the order of gravitation.

As far back as the 60's, physicist Timothy Boyer of New York city college combined formulas of classical physics with the random fields of ZPE. It was his goal to reproduce the entire quantum theory with this approach. The result: Boyer's "Stochastic Electrodynamics" produced in many cases the same results as Max Planks' Quantum Electrodynamics, among others in regard to the radiation of black bodies, with "harmonic oscillators", with Van der Waals forces as well as the Heisenberg's Uncertainty Principle. "If the physicists had taken this path around 1900 they would have done much better with this classical approach than with Plank's quantum theory", commented Boyer's colleague Peter Milonni of the Los Alamos National Laboratory.

The way this cosmic power could be used to generate energy is shown by the effect named after the Dutch Physicist, Hendrix B. Casimir. Two smooth metal plates held apart a very small distance must attract each other very powerfully. The reason: in the space between the plates there are far fewer vacuum fluctuations than in the space outside. The pressure of the radiation, therefore, pushes the plates together - as it also pushes heavenly bodies together (accordingly gravity is a macro demonstration of the Casimir effect). At the meeting of the plates an enormous amount of heat is generated - the vacuum energy is translated into useful energy. Of course this can only be done once with each pair of plates, because to separate the plates to

start a new cycle would require the application of the energy liberated in the previous cycle. Expert Ken Shoulders came up with a different solution. He wants to use a cold electrically charged plasma (in a plasma the nuclei and the electrons are separated) to generate energy. The Casimir effect is supposed to compress the plasma which would generate heat. The repulsion of the nuclei drives the dense gas apart, and a new cycle begins.

Shoulders discovered another phenomenon that could be based on the Casimir effect. "If electrons are packed together with sufficient force they no longer repel each other but form clusters. These electron clusters require no electrical conductors. For instance, they run in small rills of a ceramic body - in fact, a thousand times faster than in a semiconductor," declared the Texas researcher. An energetic spark discharge is sufficient to generate these clusters. Ultrafast chips and greatly miniaturized instruments are possible uses of such dense clusters. One thinks of extremely flat TV screens with the electronic components integrated in the screen, very tiny x-ray generators which could be inserted into the body of the patient to radiate tumors, or one hundred horsepower motors that are only slightly larger than the crankshaft.

But where does the ZPE come from? "There are two thoughts on this. One says that it is simply a part of the boundary conditions of our universe the same as the background radiation resulting from the big bang", explained vacuum expert Puthoff. The other requires a stronger imagination: the quantum fluctuations drive the trembling (to which Puthoff ascribed Heisenberg's Uncertainty Principle) of all the material particles in the universe. The sum of these motions, however, could generate the zero point fields which in turn generate the virtual particles and their radiation field, which again causes the physical particles to vibrate - something like a cat chasing its own tail. Puthoff calls this phenomenon, which possibly keeps the whole cosmos running, a "self-generating cosmological feedback", which began with an elementary random fluctuation: the big bang.

WHERE DOES THE ZERO-POINT ENERGY COME FROM?

One of the more bizarre predictions of quantum theory, which describes the microscopic world of the atom, is that each cubic centimeter of apparently empty space contains an enormous amount of energy. Physicists call it the zero-point energy because it exists even at the absolute zero of the temperature scale. But although their theories predict that it should exist, and their experiments also confirm that it does, physicists have not been able to answer the most fundamental of questions: Where does the zero-point energy come from?

Harold Puthoff, of the Institute for Advanced Studies in Austin, Texas, has spent much time trying to find an answer. His calculations show that the spectrum of electromagnetic radiation that is associated with the zero-point energy can be self-generated in a process that, he says, is "not unlike a cat chasing its own tail" (*Physical Review A*, vol 40, p 4857).

The zero-point energy is associated with all of nature's fields of force, including the electromagnetic field. It appears quite naturally in the equations that describe the "quantised" field as soon as physicists unify the theory of electromagnetism with quantum theory. Usually, though, the zero-point energy is unobserved.

Formally, physicists attribute an infinite amount of energy to this background. But, even when they impose appropriate cutoffs at high frequency, they estimate conservatively that the zero-point density is comparable to the energy density inside an atomic nucleus.

Because the numbers that describe the zero-point energy are so enormous, theorists have often questioned whether they should be taken seriously. Some have suggested that they may arise simply because the quantum theory has some defect, or because physicists are not interpreting it correctly. Usually, physicists argue over whether they should consider the fields associated with the zero-point energy as "real" or "virtual" -- that is, necessary in the mathematics of quantum theory, although perhaps not physically real.

Despite such arguments, though, no one can doubt that the fields associated with the zero-point energy produce physical consequences which are measurable in the laboratory. One example is the Lamb shift of the spectral lines of an atom. Here, the fields slightly perturb an electron in an atom so that when it makes a transition from one state to another, it emits a photon whose frequency is "shifted" slightly from its normal value.

Paul Dirac found a "cosmic coincidence", connecting the cosmic and atomic scales. Now, there may be an explanation.

Another measurable consequence of the fields associated with the zero-point energy is the Casimir effect. This is an attractive force that appears between two metal plates that are closely spaced. The Casimir force is due to so-called radiation pressure from the zero-point energy of the background electromagnetic field. In effect, some wavelengths of the field are excluded from between the plates, so reducing the energy density compared with that of empty space. The imbalance results in the plates being pushed together.

When Puthoff considers the origin of the zero-point energy, he comes to the conclusion that it can have one of two explanations. The first explanation, which he discards, is that the zero-point energy was fixed arbitrarily at the birth of the Universe, as part of its so-called boundary conditions. Puthoff believes instead that the zero-point energy may be generated by radiation from "quantum fluctuations". According to quantum theory, the particles of matter can pop into existence, then pop out again, just as long as they do so for fleetingly small intervals, determined by Heisenberg's uncertainty principle. These "quantum fluctuations" fill all of space and are the reason why physicists often refer to the "seething vacuum".

Puthoff has calculated the properties of radiation from charged particles produced by quantum fluctuations throughout the Universe. All charged particles undergoing acceleration emit electromagnetic radiation. Such radiation drops off as the inverse square of the distance from the source. But, because the average volume distribution of such particles in spherical shells about any given point source is proportional to the area of the shell -- that is, the square of the distance -- the sum of contributions from the surrounding shells will yield a radiation field with a high energy density. Puthoff believes that the field associated with the zero-point energy is such a field.

One possibility is that the zero-point fields drive the motion of all particles of matter in the Universe, and that, in turn, the sum of the particle motions throughout the Universe generates the zero-point fields. This he regards as a "self-regenerating cosmological feedback cycle".

His calculations assumed so-called inflationary cosmology, a currently popular theory of the origin of the Universe. He is able to predict the correct distribution of frequencies and the correct order of magnitude of the zero-point energy. His work supports the idea that the zero-point fields are generated dynamically.

The new calculations yield a bonus as well. Puthoff is able to derive an expression that relates the zero-point energy density to such factors as the average density of matter in the Universe and the size of the Universe.

This expression also yields a precise expression for an observed "cosmological coincidence", first pointed out by Paul Dirac, the English physicist. The coincidence is that the ratio of the strengths of the

electromagnetic force between the same two particles is very close to the ratio of the Hubble distance -- effectively the size of the Universe -- to the size of the electron.

According to Puthoffs findings, such a cosmological coincidence is simply a consequence of the cosmologically based mechanism which generates the zero-point energy. This is a neat linking of cosmological and atomic parameters and may solve the long-standing mystery.

INERTIA: DOES EMPTY SPACE PUT UP THE RESISTANCE?

BY ROBERT MATTHEWS

SCIENCE, VOL. 263, 4 FEBRUARY 1994

As a child, the Nobel Prize-winning physicist Richard Feynman asked his father why a ball in his toy wagon moved backward whenever he pulled the wagon forward. His father said that the answer lay in the tendency of moving things to keep moving, and of stationary things to stay put. "This tendency is called inertia," said Feynman senior. Then, with uncommon wisdom, he added: "But nobody knows why it is true."

That's more than even most physicists would say. To them, inertia does not need explaining, it simply "is." But since the concept was first coined by Galileo in the 17th century, some scientists have wondered if, perhaps, inertia is not intrinsic to matter at all, but is some-how acquired. Those who have tried to come to grips with inertia include Feynman junior, once he has grown up, and Albert Einstein, who tried -- and failed -- to show that inertia was related to the arrangement of matter in the universe.

Now three researchers think they have found the source of inertia -- and it turns out to be much closer to home. Inertia, they say, comes from the apparently empty space that surrounds us all -- or rather, from the buzz of activity that, according to quantum theory, fills even a perfect vacuum where subatomic particles are being created and annihilated in the blink of an eye. It is this ever-present sea of energy that the researchers believe resists the acceleration of mass, and so creates inertia.

Reaching this conclusion took more than just a simple application of quantum theory for Bernhard Haisch of Lockheed Palo Alto Research Laboratory, Alfonso Rueda of the California State University at Long Beach, and Hal Puthoff at the Institute for Advanced Studies at Austin, Texas. Their idea, published in the 1 February issue of *Physical Review A* is based on an esoteric mathematical treatment of the vacuum and a long-forgotten attempt by the Soviet theorist and dissident Andrei Sakharov to explain another great mystery, gravity. These unfamiliar foundations, together with the new proposal's boldness, would be more than enough to stir up controversy. But the paper

Seeking a reference frame, Mach defined inertia with respect to distant stars.

Another try. Einstein tried to incorporate Mach's principle into general relativity.

raises an even more provocative notion: that inertia, once understood, might be controlled.

It is a bit too early to be talking about building inertia-free starships, the researchers say, but they maintain that there may soon be hard evidence supporting their claim, from experiments that will search for changes in the mass of electrons when they are exposed to powerful laser beams. Certainly many of their colleagues are intrigued. Says Stanford University astrophysicist Peter Sturrock, "No one would say that it's the last word, but I think it may really be one of the first words in what could be a very interesting approach."

One inspiration for the effort was a much earlier try, by the German philosopher-physicist Ernst Mach. In 1872, Mach argued that acceleration -- and hence inertia -- is not absolute, but only has meaning within a frame of reference. For Mach, that frame of reference consisted of the other matter in the universe: After all, in utterly empty space, how do you know you are moving? Einstein later tried and failed to work that notion into general relativity. Haisch and his colleagues also invoke a frame of reference: not the distant stars, but the quantum vacuum.

The seething activity of the vacuum is an upshot of Heisenberg's uncertainty principle, one of the key results of quantum theory. The principle is best known for setting limits to the accuracy with which it is possible to measure simultaneously certain attributes of a particle, such as its position and momentum. But the flip-side of this uncertainty is that a particle and a matching anti-particle can spontaneously appear out of thin air, so long as they recombine and annihilate each other so fast no one would know. During their fleeting existence, these "virtual particles" make their presence felt in many ways, including slight shifts in the spectrum of hydrogen, the irreducible electronic noise in semiconductors and, Haisch and his colleagues now claim, inertia.

Meeting with Resistance

Their argument draws on a curious quantum vacuum phenomenon first described by the British physicist Paul Davies (now at the University of Adelaide in Australia) and William Unruh of the University of British Columbia in the mid-1970s. If you move at a constant speed through the quantum sea of virtual particles, it looks the same in all directions. But as soon as you start to accelerate through it, theory predicts that the vacuum gives the appearance of being a tepid "sea" of heat radiation.

Although far too small to measure, the Davies-Unruh effect led Haisch, a high-energy astrophysicist, and Puthoff, a quantum theorist, to wonder independently about a connection with inertia. Could it be that accelerating through the vacuum produces other effects, too -- like the resistance to

acceleration that we call inertia? While still mulling over the idea, Haisch met with Rueda, an electrodynamics theorist with considerable experience in the techniques needed to attack such a question. When they learned of Puthoff's similar ideas, Haisch and Rueda decided to join forces with him.

In their analysis, the trio set aside conventional quantum theory. Instead, they opted for an approach known as stochastic electrodynamics (SED), which accepts the existence of the vacuum fluctuations a priori, then applies an entirely classical (i.e., non-quantum) approach to particles and electromagnetism. Since the 1960s, a number of theorists, including Rueda, have shown that SED can give a perfectly accurate account of bizarre quantum effects without becoming embroiled in complex quantum theory.

In their intensely mathematical paper, Haisch and his colleagues wield SED to argue that inertia results from a Lorentz force, familiar to physicists as the force that deflects a charged particle moving through a magnetic field. For inertia, it is the vacuum fluctuations that produce the magnetic field, and it is the charged subatomic particles making up objects, the more particles it contains, and hence the stronger the resistance, and the greater the object's inertia.

Predictably for a grand claim based on obscure theory, peer reaction is mixed. On the one hand is Stanford's Sturrock, who calls it "very interesting, and potentially very important." On the other is Peter Milonni, a specialist on quantum vacuum processes at the Los Alamos National Laboratory, who says, "I don't think much of the work," complaining "I see a lot of claims being made that are just not backed up."

Cosmologist Paul Wesson of the University of Waterloo, Canada, an authority on the links between the subatomic and cosmic worlds, is "glad that someone is trying to return to the question of inertia again." But he is concerned about "the astrophysical and cosmological implications" of the work. Wesson's concerns center on the cosmological constant, best known as an add-on to Einstein's equations of general relativity that endows free space with extra energy and gives it a gravitational effect. Einstein eventually dropped the constant because it was inelegant, but some cosmologists would like to resurrect it because it would solve some of their most intractable problems, such as the age of the universe and its missing mass (*Science*, 5 November 1993, p. 846).

The new vacuum-based theory of inertia devised by Haisch and his colleagues does just that: It requires an energy-rich vacuum, which implies a cosmological constant. The problem is that the constant implied by the new theory is much bigger than the one required to solve the other problems of cosmology. Says Wesson: "The vacuum has so much energy associated with it that it would have negative astrophysical implications. Those would have to be cleared up."

Overcoming inertia.

Haisch and his colleagues agree that there is a problem and suggest an answer, in the form of a controversial theory of gravity proposed by Sakharov in the late 1960s. One consequence of Sakharov's theory is that vacuum energy can't generate a gravitational field -- and so cannot create a problematic cosmological constant. Solving one unconventional theory's problems by invoking another unconventional theory is unlikely to win many converts, and Haisch agrees that the team's work needs refining. But he hopes to do it with the help of other researchers, who might be lured by the tantalizing implications of the theory -- among them the possibility that by altering the properties of the vacuum, researchers might control inertia.

Physicists have known for years that the quantum vacuum can be manipulated. In the so-called Casimir effect, two metal plates brought close together distort the quantum vacuum, which responds by producing an attractive force between the plates. If the quantum vacuum could be distorted on a larger scale, says Haisch, "then we open a door on a way of perhaps someday controlling inertia -- and we had no inkling that was even possible in principle before."

Experiments slated for later this year at the Stanford Linear Accelerator Center (SLAC) may provide Haisch and his colleagues with the evidence they need to convince skeptics. Physicist Kirk McDonald of Princeton University and colleagues from a number of other universities plan to expose high-energy electrons produced at SLAC to a terawatt beam from a neodymium-YAG laser. Testing the inertia theory isn't the main aim of the experiment. But if the theory is correct, the intense electromagnetic field experienced by the electrons as they enter the beam will affect their interaction with the quantum vacuum's own field -- and so change their inertia.

A favorable outcome, Haisch thinks, might be just what he and his colleagues need to overcome any resistance -- or is it inertia? -- they are meeting in the scientific community. "If nothing else," he says, "controlling inertia is a possibility that might just encourage others to dig deeper."

FILLING THE VOID

THE ECONOMIST, FEBRUARY 1ST, 1997

Nature, famously, abhors a vacuum. People are generally just bored by vacuums, because they believe them to be empty spaces in which, almost by definition, nothing ever happens. For nearly 50 years, however, quantum physicists have had a very different view. A branch of quantum theory known as quantum electrodynamics (QED) says that a vacuum, far from being static or empty, teems with transient "virtual" particles (especially photons, the particles of light) that keep popping weirdly into existence and then disappearing again. But for all their theoretical confidence, physicists have found it hard to demonstrate this.

Until now, that is. Steve Lamoreaux, who works at the Los Alamos National Laboratory in New Mexico, has just done something peculiar. As he reported in a recent issue of *Physical Review Letters*, he has shown that if you take two electrically conducting plates and put them close together in a vacuum, they are pushed toward each other by a force conjured up out of the nothingness -- the Casimir force.

Hendrik Casimir is a Dutch physicist. In 1948, when QED was still a new theory, he suggested that it would be possible to get Nature to give you something for nothing, despite her being a well-known skinflint.

Commonsense suggests that a vacuum, being empty, has zero energy. But Heisenberg's uncertainty principle, a mainstay of quantum theory, says that "zero" is not a precise quantity. The vacuum is filled with short-lived bursts of energy. And, QED predicted, these energy bursts can turn into particles such as photons that exist for a very short period--so short that they are not directly observable. But their presence is keenly felt. According to QED, they carry the forces that hold real particles -- and hence the material world -- together.

Dr Casimir suggested that their effects could be more permanent in another way too. Quantum theory holds that particles in general (and photons in particular) have a simultaneous existence as waves. And as waves, they need space in which to vibrate. Just as the short strings of a violin cannot produce the deep, long-wavelength notes of a double bass, so photons -- which are vibrations not of string but electromagnetic fields -- are constrained by things that conduct electricity. A photon can exist between two conducting plates only if its wavelength is less than twice the distance between the plates. As a consequence, the longest virtual wavelengths are missing from the gap between the plates used in Dr Lamoreaux's experiment.

On the other side of each plate, though, the full range of photons can come briefly into existence. The net result is a difference in the radiation pressure -- the feeble force exerted by photons on other objects -- between the insides and the outsides of the two plates. This difference, which Dr Casimir predicted, pushes them slightly together.

Detecting the Casimir force between large objects calls for subtlety. Previous attempts have either failed to achieve sufficient accuracy or merely measured the force between a plate and an atom. Even Dr Lamoreaux's experiment did not manage to measure the force between two flat plates (the ideal test), because of the difficulty of keeping them perfectly parallel while less than a thousandth of a millimetre apart.

Instead, he used one curved and one flat plate. The curved plate sat on a mounting that was finely adjustable backwards and forwards. The flat one was at one end of a bar that was in turn suspended from a fibre -- an arrangement known as a torsion pendulum. The other end of the suspended bar formed part of an electrical capacitor. This allowed the pendulum to be held steady by applying slight changes to the voltage across the capacitor.

By moving the curved plate to and fro, Dr Lamoreaux could change the Casimir force between the plates and make the pendulum try to rotate one way or the other. Then, by measuring the change in voltage needed to stop this from happening, he could work out the strength of the Casimir force. Since the whole assembly -- which sat inside a vacuum chamber -- was so sensitive that it could detect somebody standing nearby from the way his weight tilted the laboratory floor, a very accurate measurement was possible.

The force between the plates was gratifyingly small: about that exerted by a speck of dust lying on a bench top. Also gratifying was the cost of the experiment. Dr Lamoreaux's set-up (which began life as a student project) cost only a few hundred dollars. Not quite something for nothing, but in the world of physics, a close approximation.

EXPLOITING ZERO-POINT ENERGY

ENERGY FILLS EMPTY SPACE, BUT IS THERE A LOT TO BE TAPPED, A SOME PROFOUND? PROBABLY NOT

BY PHILIP YAM, SCIENTIFIC AMERICAN, DECEMBER 1997

Something for nothing. That's the reason for the gurgling water, ultrasonic transducers, heat-measuring calorimeters, data-plotting software and other technological trappings -- some seemingly of the backyard variety -- inside the Institute for Advanced Studies in Austin, Tex. One would not confuse this laboratory with the similarly named but far more renowned one in Princeton, N.J., where Albert Einstein and other physicists have probed fundamental secrets of space and time. The one in Austin is more modestly appointed, but its goals are no less revolutionary. The researchers here test machinery that, inventors assert, can extract energy from empty space.

Claims for perpetual-motion machines and other free-energy devices still persist, of course, even though they inevitably turn out to violate at least one law of thermodynamics. Energy in the vacuum, though, is very much real. According to modern physics, a vacuum isn't a pocket of nothingness. It churns with unseen activity even at absolute zero, the temperature defined as the point at which all molecular motion ceases.

Exactly how much "zero-point energy" resides in the vacuum is unknown. Some cosmologists have speculated that at the beginning of the universe, when conditions everywhere were more like those inside a black hole, vacuum energy was high and may have even triggered the big bang. Today the energy level should be lower. But to a few optimists, a rich supply still awaits if only we knew how to tap into it. These maverick proponents have postulated that the zero-point energy could explain "cold fusion," inertia and other phenomena and might someday serve as part of a "negative mass" system for propelling spacecraft. In an interview taped for PBS's *Scientific American Frontiers*, which aired in November, Harold E. Puthoff, the director of the Institute for Advanced Studies, observed: "For the chauvinists in the field like ourselves, we think the 21st century could be the zero-point-energy age."

That conceit is not shared by the majority of physicists; some even regard such optimism as pseudo-science that could leech funds from legitimate research. The conventional view is that the energy in the vacuum is minuscule. In fact, were it infinite, the nature of the universe would be vastly different: you

would not be able to see in a straight line beyond a few kilometers. "The vacuum has some mystique about it," remarks Peter W. Milonni, a physicist at Los Alamos National Laboratory who wrote a text on the subject in 1994 called *The Quantum Vacuum*. "One has to be really careful about taking the concept too naively." Steve K. Lamoreaux, also at Los Alamos, is harsher: "The zero-point-energy community is more successful at advertising and self-promotion than they are at carrying out bona fide scientific research."

The concept of zero-point energy derives from a well-known idea in quantum mechanics, the science that accounts for the behavior of particles near the atom's size. Specifically, zeropoint energy emerges from Heisenberg's uncertainty principle, which limits the accuracy of measurements. The German physicist Werner Heisenberg determined in 1927 that it is impossible to learn both the position and the momentum of a particle to some high degree of accuracy: if the position is known perfectly, then the momentum is completely unknown, and vice versa. That's why at absolute zero, a particle must still be jittering about: if it were at a complete standstill, its momentum and position would both be known precisely and simultaneously, violating the uncertainty principle.

Energy and Uncertainty

Like position and momentum, energy and time also obey Heisenberg's rule. Residual energy must therefore exist in empty space: to be certain that the energy was zero, one would have to take energy measurements in that volume of space forever. And given the equivalence of mass and energy expressed by Einstein's $E = mc^2$, the vacuum energy must be able to create particles. They flash briefly into existence and expire within an interval dictated by the uncertainty principle.

This zero-point energy (which comes from all the types of force fields--electromagnetic, gravitational and nuclear) makes itself felt in several ways, most of them obvious only to a physicist. One is the Lamb shift, which refers to a slight frequency alteration in the light emitted by an excited atom. Another is a particular kind of inescapable, low-level noise that registers in electronic and optical equipment.

Perhaps the most dramatic example, though, is the Casimir effect. In 1948 the Dutch physicist H.B.G. Casimir calculated that two metal plates brought sufficiently close together will attract each other very slightly. The reason is that the narrow distance between the plates allows only small, high-frequency electromagnetic "modes" of the vacuum energy to squeeze in between. The plates block out most of the other, bigger modes. In a way, each plate acts as an airplane wing, which creates low pressure on one side and high pressure on the other. The difference in force knocks the plates toward each other.

**Quantum
Fluctuations, ripples
that form the basis for
energy in a vacuum,
pervade the fabric of
space and time.**

While at the University of Washington, Lamoreaux conducted the most precise measurement of the Casimir effect. Helped by his student Dev Sen, Lamoreaux used gold-coated quartz surfaces as his plates. One plate was attached to the end of a sensitive torsion pendulum; if that plate moved toward the other, the pendulum would twist. A laser could measure the twisting of the pendulum down to 0.01-micron accuracy. A current applied to a stack of piezoelectric components moved one Casimir plate; an electronic feedback system countered that movement, keeping the pendulum still. Zero-point-energy effects showed up as changes in the amount of current needed to maintain the pendulum's position. Lamoreaux found that the plates generated about

100 microdynes (one nanonewton) of force. That "corresponds to the weight of a blood cell in the earth's gravitational field," Lamoreaux states. The result falls within 5 percent of Casimir's prediction for that particular plate separation and geometry.

Zero for Zero-Point Devices

Demonstrating the existence of zero-point energy is one thing; extracting useful amounts is another. Puthoff's institute, which he likens to a mini Bureau of Standards, has examined about 10 devices over the past 10 years and found nothing workable.

One contraption, whose Russian inventor claimed could produce kilowatts of excess heat, supposedly relied on sonoluminescence, the conversion of sound into light. Bombarding water with sound to create air bubbles can, under the right conditions, lead to bubbles that collapse and give off flashes of light. Conventional thinking explains sonoluminescence in terms of a shock wave launched within the collapsing bubble, which heats the interior to a flash point.

Following up on the work of the late Nobelist Julian Schwinger, a few workers cite zero-point energy as the cause. Basically, the surface of the bubble is supposed to act as the Casimir force plates; as the bubble shrinks, it starts to exclude the bigger modes of the vacuum energy, which is converted to light. That theory notwithstanding, Puthoff and his colleague Scott Little tested the device and changed the details a number of times but never found excess energy.

Puthoff believes atoms, not bubbles, offer a better approach. His idea hinges on an unproved hypothesis: that zeropoint energy is what keeps electrons in an atom orbiting the nucleus. In classical physics, circulating charges like an orbiting electron lose energy through radiation; what keeps the electron zipping around the nucleus is, to Puthoff, zero-point energy that the electron continuously absorbs. (Quantum mechanics as originally formulated

Virtual Particles can spontaneously flash into existence from the energy of quantum fluctuations. The particles, which arise as matter-antimatter twins, can interact but must, in accordance with Heisenberg's uncertainty principle, disappear within an interval set by Planck's constant, h .

simply states that an electron in an atom must have some minimum, ground-state energy.) Physicists have demonstrated that a small enough cavity can suppress the natural inclination of a trapped, excited particle to give up some energy and drop to a lower energy state [see "Cavity Quantum Electrodynamics," by Serge Haroche and Jean-Michel Raimond; SCIENTIFIC AMERICAN, April 1993]. Basically, the cavity is so small that it can exclude some of the lower-frequency vacuum fluctuations, which the excited atom needs to emit light and drop to a lower energy level. The cavity in effect controls the vacuum fluctuations.

Under the right circumstances, Puthoff reasons, one could effectively manipulate the vacuum so that a new, lower ground state appears. The electron would then drop to the lower ground state--in effect, the atom would become smaller--and give up some energy in the process. "It implies that hydrogen or deuterium injected into cavities might produce excess energy," Puthoff says. This possibility might explain cold-fusion experiments, he notes -- in other words, the occasional positive results reported in cold-fusion tests might really be indicators of zero-point energy (rather than, one would assume, wishful thinking).

Work in cavity quantum electrodynamics is experimentally challenging in its own right, however, so it is not clear how practical an energy supply from "shrinking atoms" could be. The Austin institute is testing a device that could be interpreted as manipulating the vacuum, although Puthoff declines to provide details, citing proprietary nondisclosure agreements with its designers.

How Much in Nothing?

Underlying these attempts to tap the vacuum is the assumption that empty space holds enough energy to be tapped. Considering just the fluctuations in the electromagnetic force, the mathematics of quantum mechanics suggest that any given volume of empty space could contain an infinite number of vacuum-energy frequencies -- and hence, an infinite supply of energy. (That does not even count the contributions from other forces.) This sea of energy is largely invisible to us, according to the zeropoint-energy chauvinists, because it is completely uniform, bombarding us from all directions such that the net force acting on any object is zero.

But just because equations produce an infinity does not mean that an infinity exists in any practical sense. In fact, physicists quite often "renormalize" equations to get rid of infinities, so that they can ascribe physical meaning to their numbers. An example is the calculation of the electron's mass from theoretical principles, which at face value leads to an unrealistic, infinite mass. The same kind of mathematical sleight-of-hand might need to be done for

Casimir effect is the motion of two parallel plates because of quantum fluctuations in a vacuum. The plates are so close together that only small fluctuations fit in between; the bigger modes are excluded. They exert a total force greater than that by the smaller modes and hence push the plates together. The effect was observed by Steve K. Lamoreaux, now at Los Alamos National Laboratory, who relied on a torsion pendulum. A current applied to the piezoelectric stack tried to move the Casimir plate on the pendulum; the compensator plates held the pendulum still. The voltage needed to prevent any twisting served as a measure of the Casimir effect.

vacuum-energy calculations. "Somehow the notion that the energy is infinite is too naive," Milonni says.

In fact, several signs indicate that the amount of energy in the vacuum isn't worth writing home about. Lamoreaux's experiment could roughly be considered to have extracted 10^{-5} joule. That paltry quantity would seem to be damning evidence that not much can be extracted from empty space. But Puthoff counters that Casimir plates are macroscopic objects. What is needed for practical energy extraction are many plates, say, some 10²³ of them. That might be possible with systems that rely on small particles, such as atoms. "What you lose in energy per interaction, you gain in the number of interactions," he asserts.

Milonni replies by noting that Lamoreaux's plates themselves are made of atoms, so that effectively there were 10²³ particles involved. The low Casimir result still indicates, by his figures, that the plates would need to be kilometers long to generate even a kilogram of force. Moreover, there is a cost in extracting the energy of the plates coming together, Milonni says: "You have to pull the plates apart, too."

Another argument for a minuscule vacuum energy is that the fabric of space and time, though slightly curved near objects, is pretty much flat overall. Draw a triangle in space and the sum of its angles is 180 degrees, as it would be on a flat piece of paper. (The angles of a triangle on a sphere, conversely, sum to more than 180 degrees.) Because energy is equivalent to matter, and matter exerts a gravitational force, cosmologists expect that an energy-rich vacuum would create a strong gravity field that distorts space and time as it is seen today. The whole universe would be evolving in a different manner.

That argument ties into the cosmological constant, a concept that Einstein first developed, then discarded. In the equations that describe the state of the universe, the cosmological constant--which incorporates zeropoint energy--is in a sense a term that can counteract gravity. Astronomical observations suggest the constant must be nearly zero. Consequently, if the vacuum energy really is large, then some other force that contributes to the constant must offset it. And as physicist Steven Weinberg of the University of Texas notes in his 1992 book *Dreams of a Final Theory*, that offset feels unnatural: calculations that sidestep the infinity terms produce a vacuum energy 120 orders of magnitude greater than the nearly zero value of the cosmological constant, so that other force must be opposite but identical in magnitude to the vacuum energy out to 120 decimal places.

Puthoff replies that the connection between the cosmological constant and zero-point energy is more complex than is often realized. "Obviously, the zeropoint-energy problem and the cosmological constant, though related, are really different problems," Puthoff argues, noting that predictions of quantum

Zero-point energy was purportedly tapped with a machine that made use of ultrasonically generated bubbles. Such devices are tested by Harold E. Puthoff, director of the Institute for Advanced Studies in Austin, Tex. So far no apparatus has been found to produce a net gain in energy.

mechanics have proved correct time and again and that instead something is still missing from cosmologists' thinking.

Such disagreements in science are not unusual, especially considering how little is really known about zero-point energy. But those would-be utility moguls who think tapping zeropoint energy is a worthwhile pursuit irritate some mainstream scientists. "I was rather dismayed at the attention from what I consider a kook community," Lamoreaux says of his celebrity status among zero-point aficionados after publishing his Casimir effect result. "It trivializes and abuses my work." More galling, though, is that these "pseudoscientists secure funding, perhaps governmental, to carry on with their research," he charges.

Puthoff's institute receives a little government money but gets most of its funds from contracts with private firms. Others are backed more explicitly by public money. This past August the National Aeronautics and Space Administration sponsored a meeting called the "Breakthrough Propulsion Physics Workshop." According to participants, zero-point energy became a high priority among those trying to figure out which "breakthroughs" should be pursued.

The propulsion application depends on a speculation put forth in 1994 by Puthoff, Bernhard Haisch of Lockheed Pale Alto Research Laboratory and Alfonso Rueda of California State University at Long Beach. They suggested that inertia -- the resistance that objects put up when they are accelerated -- stems from the drag effects of moving through the zero-point field. Because the zeropoint field can be manipulated in quantum experiments, Puthoff reasons, it should be possible to lessen an object's inertia and hence, for a rocket, reduce the fuel burden. Puthoff and his colleagues have been trying to prove this inertia-origin hypothesis--a sensitive pendulum should be able to detect a zero-point-energy "wake" left by a moving object--but Puthoff says they have not managed to isolate their system well enough to do so.

More conventional scientists decried the channeling of NASA funds to a meeting where real science was lacking. "We hardly talked about the physics" of the proposals, complained Milonni, adding that during one of the breakout sessions "there was a guy talking about astral projection."

Certainly, there should be room for far-out, potentially revolutionary ideas, but not at the expense of solid science. "One has to keep an open mind, but the concepts I've seen so far would violate energy conservation," Milonni concludes. In sizing up zero-point-energy schemes, it may be best to keep in mind the old caveat emptor: if it sounds too good to be true, it probably is.

THE WAVE

BY TOBY GROTZ

The Navajo And The Bhuddist

"There are worlds within worlds Christa. Everything in our world is connected by the delicate strands of the web of life, which is balanced between forces of destruction and the magic forces of creation". The Magi to Christa in the movie 'Fergully'.

The Forces Of Nature

In May of 1921, Walter Russell, a sculptor, painter, and later a President of the Academy of Arts and Sciences, entered into a prolonged state of heightened awareness or samadhi. His experience allowed him to see the manner in which the creator, or illumined one as he described it, gave manifestation to the elements of matter and the gravitational and electrical effects of nature. These primordial forces were best described in a visual format in a painting by Russell entitled "The Wave".

A full color photograph of Russell's painting "The Wave", precedes the text in his book 'The Secret of Light'. (Available from The University of Science and Philosophy, call 1-800-882-5683 to order or for catalog). Viewed from the front, in the schematic form of a technical blueprint, the wave seems to be identical to the patterns present in Navajo weavings. These symbols are a front view of the vortex motions of the simultaneous forces of creation and disintegration. The Navajo rug symbols and the wave explain the dual wave and particle like nature of atomic physics. Viewed end on, the symbol becomes the yin-yang sign of eastern philosophy.

It is also a pictorial representation of Zero Point energy and Scaler fields. A complete mathematical description of the yin-yang symbol is presented by Eldon Byrd in Volume 1, Number 2, of The Journal of the USPA.

It is possible that ancient shamans also were able to visualize the wave of creation. Having an understanding of the mechanics of nature, as represented by the wave, it would be possible to develop a technology that could utilize the forces of nature for the benefit of the tribe.

Using The Fundamental Forces Of Nature For The Benefit Of

Mankind

I had the good fortune of being able to present this to Tom Bearden this summer at the 27th IECEC conference. Tom pointed out that sound vibrations could be used to accomplish the same scalar wave technology that Tesla, Moray, Hubbard, Keely, Hendershot, and others may have done electrically and mechanically. Through the use of chanting the wave could be manipulated to cause physical phenomenon to occur. Thus the rain dance in the desert southwest, the ability to move large stone blocks through the manipulation of gravity, the instantaneous healing of the sick, could all be accomplished through chanting. As Terence McKenna points out in 'The Archaic Revival (Speculations on Psychedelic Mushrooms, the Amazon, Virtual Reality, UFOs, Evolution, Shamanism, the Rebirth of the Goddess, and the End of History)', "Chanting and singing are worldwide shaministic practices. The Shamanic singers navigate through a space with which we have lost touch as a society."

Non-Polluting Energy Generation.

The great American inventor, Nikola Tesla, prophesied the potential inherent in the wave in 1891 in a speech before the American Institute of Electrical Engineers; "Ere many generations pass, our machinery will be driven by a power obtainable at any point in the universe.....Throughout space there is energy....it is a mere question of time when men will succeed in attaching their machinery to the very wheelwork of nature."

The wave is the precursor to matter. It is the fabric of sub space, if you will. It is non-material and exists in a dimension removed from view. The wave controls and results in the formation of matter which is detectable from our dimension. This is why we seem to see a duality of wave and particle like nature in atomic and photonic structure. There is no paradox. The wave is a wave when it is a wave and the particle is a particle when it is a particle. The wave becomes the particle which then become the wave.

The Possibility of Elemental Transmutation.

Tesla was able to verbally describe what Russell had drawn when he said "Every particle of matter is composed of a primary substance--the ether--filling all space. The atom of any elementary body is differentiated from the rest of this tenuous substance merely by a spinning motion like a whirl in a calm lake.

By being set in movement ether becomes palpable matter; the movement arrested, the primary substance reverts to its normal state and becomes imperceptible....To create and annihilate material substance, to cause at will its birth and death, would be man's most consequential deed--his greatest

achievement, which would place him beside his creator, make him fulfill his ultimate destiny. (Nikola Tesla, in a letter to the "Actors Fund Fair", May 13th, 1907.)

The action of the vortexes of integration and disintegration were again described by Tesla in 1930. "Long ago he [man] recognized that all perceptible matter comes from a primary substance, or tenuity beyond conception, filling all space, the Akasha or luminiferous ether, which is acted on by the life giving Prana, or creative force, calling into existence in never ending cycles all things and phenomena. The primary substance, thrown into infinitesimal whirls of prodigious velocity, becomes gross matter; the force subsiding, the motion ceases and matter disappears, reverting to the primary substance. (Nikola Tesla, "Man's Greatest Achievement")

Notice two things in this description. First that Tesla had seen that this process had been understood by ancient people and second that he used words from eastern philosophy to describe the process. Tesla had attended the lectures of Swami Vivekananda in New York City in 1896 and had been inspired by Vivikananda's explanation of Vedic cosmology. (See 'The Influence of Vedic Philosophy on Nikola Tesla's Understanding of Free Energy', 15th Annual USPA Conference, Sacramento, California, audio and video tape available, paper to be published, fall of 1992 in the Journal Of The USPA) It was only through the use of vedic terminology that Tesla was able to describe the forces of nature, western science lacked the vocabulary as well as the understanding.

Descriptions Of The Universal Forces By Walter Russell

The wave is described by Russell as causing "the integration of matter at poles and disintegration at equators. Matter integrates by the contraction of one pair of spirals around the shafts which wind it into spheres by the way of its poles, and disintegrates it by the expansion of the other pair which unwinds it by the way of equators. (Secret of Light, p. 251.)

Gravitation and Radiation

"Every wave is considered a compression-expansion pump. The whole universe is a giant pump. The two-way piston of the universal pump constitutes the universal heartbeat. A one-way universe is as impossible as a one way pump is possible. The compressed condition of this universe is exactly equal to the expanded condition. The compressed condition is gravitation.

The expanded condition is radiation. Gravitation and radiation are equal opposites....This universe of electric waves is divided into wave fields.

Each wave field is equally divided by contraction of gravitation and expansion of radiation." (A New Concept of the Universe p. 23.)

"Electricity...creates tensions and strains, which we call electric potential. Electric potential is the measure of compression at any one point in the universe. Gravity is evidenced wherever compression from without is maximum. Gravity is a focal point from which matter desires to explode outwardly. Gravity does not pull inwardly from within as the deceptive illusion of Nature would have you believe. Neither is it the attractive force which Newton's senses were deceived into believing, for a center of gravity is a point of maximum electric potential." (Atomic Suicide, p. 89.)

Electricity And Magnetism

"Electricity is the power force of the universe. Electricity accumulates power into high potential from the universal constant at the sacrifice of one of its time dimensions. Electricity is the force of resistance to the established speed of the universal constant of energy...Electricity is the generative force.

Magnetism is the speed force, the time force, of the universe. Magnetism dissipates the high potential power dimension and transforms it into time dimension of low potential.

Magnetism is the force which works toward a return to the established motion of the universal constant of energy...Magnetism is the radiative force." (The Universal One, p. 68.)

The Nine Octave Wave of the Elements, the Basis for Transmutation of Elements.

"Every completed idea in nature is expressed in nine efforts - or stages - which are eight octave waves plus the matured centering amplitude wave of the whole nine octave cycle.

Each octave of the elements grows from its inert gas just as a tree grows from a seed. The inert gases record and store for repetition all that has gone before in that octave.

By dividing the entire nine-octave cycle into its two opposite half cycles, one half being generoactive and the other half being equally radioactive, a comprehensive base for transmutation will replace the present concept of dislodging electrons, or adding to them, to transmute one into another.

The age of transmutation will come only through the transformation of man, and man's transformation can only come only "by the renewing of his Mind" through new knowing. It has ever been that way since the dawn of Consciousness, and will ever be" (A New Concept Of The Universe, pp. 115, 119.)

*"MAN DOES NOT WEAVE THE WEB OF LIFE, HE IS BUT A STRAND IN
IT. ANYTHING HE DOES TO THE WEB, HE DOES TO HIMSELF"*

- Chief Seattle, 1855

QUANTUM FLUCTUATIONS OF EMPTY SPACE: A NEW ROSETTA STONE OF PHYSICS?

BY DR HAL PUTHOFF

In a recent article in the popular press (The Economist, January 7, 1989, pp. 71-74) it was noted how many of this century's new technologies depend on the Alice-in-Wonderland physics of quantum mechanics, with all of its seeming absurdities.

For starters, one begins with the observation that classical physics tells us that atoms, which can be likened to a miniature solar system with electron planets orbiting a nuclear sun, should not exist.

The circling electrons should radiate away their energy like microscopic radio antennas and spiral into the nucleus. But atoms do exist, and multitudinous other phenomena which don't obey the rules do occur.

To resolve this cognitive dissonance physicists introduced quantum mechanics, which is essentially a set of mathematical rules to describe what in fact does happen. But when we re-ask the question, "why didn't the electron radiate away its energy?" the answer is, basically, "well, in quantum theory it doesn't."

It's at this point that not only the layman but some physicists can begin to feel that someone's not playing fair. I say only some physicists because the majority of working physicists are content simply to use quantum rules that work, that describe (if only statistically) what will happen in a given experiment under certain conditions.

These are the so-called "logical positivists" who, in a philosophical sense, are like the news reporter whose only interest is the bottom line.

There are nevertheless individuals here and there who still want to know why the electron didn't radiate, why Einstein's equations are in this form and not another, where does the ubiquitous zero-point energy that fills even empty space come from, why quantum theory, and perhaps the biggest question of all, how did the universe get started anyway?

Surprisingly enough, there may be answers to these seemingly unanswerable meta-level questions. Perhaps even more surprising, they seem to be emerging, as a recent book title put it, from "Something called Nothing" (1), or to put it more correctly, from empty space, the vacuum, the void.

To comprehend the significance of this statement, we will have to take a detour into the phenomenon of fluctuations with which quantum theory abounds, including the fluctuations of empty space itself.

Before the advent of quantum theory, physics taught that any simple oscillator such as a pendulum, when excited, would eventually come to rest if not continuously energized by some outside force such as a spring. This is because of friction losses in the system.

After it was recognized that quantum theory was a more accurate representation of nature, one of the findings of quantum theory was that such an oscillator would in fact not come to total rest but rather would continue to "jiggle" randomly about its resting point with a small amount of energy always present, the so-called "zero-point energy."

Although it may not be observable to the eye on your grandfather clock because it is so minute, it is nonetheless very real, and in many physical systems has important consequences.

One example is the presence of a certain amount of "noise" in a microwave receiver that can never be gotten rid of, no matter how perfect the technology. This is an example which shows that not only physical devices such as pendulums have this property of incessant fluctuation, but also fields, such as electromagnetic fields (radio waves, microwaves, light, X-rays, etc.).

As it turns out, even though the zero-point energy in any particular mode of an electromagnetic field is minute, there are so many possible modes of propagation (frequencies, directions) in open space, the zero-point energy summed up over all possible modes is quite enormous; in fact, greater than, for example, nuclear energy densities. And this in all of so-called "empty" space around us. Let us concentrate on the effects of such electromagnetic zero-point fluctuations.

With such large values, it might seem that the effects of electromagnetic zero-point energy should be quite obvious, but this is not the case because of its extremely uniform density.

Just as a vase standing in a room is not likely to fall over spontaneously, so a vase bombarded uniformly on all sides by millions of ping pong balls would not do likewise because of the balanced conditions of the uniform bombardment.

The only evidence of such a barrage might be minute jiggling of the vase, and similar mechanisms are thought to be involved in the quantum jiggle of zero-point motion. However, there are certain conditions in which the uniformity of the background electromagnetic zero-point energy is slightly disturbed and leads to physical effects.

One is the slight perturbation of the lines seen from transitions between atomic states known as the Lamb Shift (2), named after its discoverer, Willis Lamb.

Another, also named for its discoverer, is the Casimir Effect, a unique attractive quantum force between closely-spaced metal plates.

An elegant analysis by Milonni et. al. at Los Angeles National Laboratory (3) shows the Casimir force to be due to radiation pressure from the background electromagnetic zero-point energy which has become unbalanced due to the presence of the plates, and which results in the plates being pushed together.

From this it would seem that it might be possible to extract electrical energy from the vacuum, and indeed the possibility of doing so (at least in principle) has been shown in a paper of that same name by Robert Forward (4) at Hughes Research Laboratories in Malibu, California.

What does this have to do with our basic questions? Let's start with the question as to why the electron in a simple hydrogen atom doesn't radiate as it circles the proton in its stable ground state atomic orbit.

This issue has been re-addressed in a recent paper by the author, this time taking into account what has been learned over the years about the effects of zero-point energy. (5) There it is shown that the electron can be seen as continually radiating away its energy as predicted by classical theory, but simultaneously absorbing a compensating amount of energy from the ever-present sea of zero-point energy in which the atom is immersed, and an assumed equilibrium between these two processes leads to the correct values for the parameters known to define the ground-state orbit.

Thus the ground-state orbit is set by a dynamic equilibrium in which collapse of the state is prevented by the presence of the zero-point energy. The significance of this observation is that the very stability of matter itself appears to depend on the presence of the underlying sea of electromagnetic zero-point energy.

With regard to the gravitational attraction that is described so well by Einstein's theory, its fundamental nature is still not well understood. Whether addressed simply in terms of Newton's Law, or with the full rigor of general relativity, gravitational theory is basically descriptive in nature, without revealing the underlying dynamics for that description.

As a result, attempts to unify gravity with the other forces (electromagnetic, strong and weak nuclear forces) or to develop a quantum theory of gravity have foundered again and again on difficulties that can be traced back to a lack of understanding at a fundamental level.

To rectify these difficulties, theorists by and large have resorted to ever-increasing levels of mathematical sophistication and abstraction, as in the recent development of supergravity and superstring theories.

Taking a completely different tack when addressing these difficulties in the sixties, the well-known Russian physicist Andrei Sakharov put forward the somewhat radical hypothesis that gravitation might not be a fundamental interaction at all, but rather a secondary or residual effect associated with other (non-gravitational) fields. (6)

Specifically, Sakharov suggested that gravity might be an induced effect brought about by changes in the zero-point energy of the vacuum, due to the presence of matter.

If correct, gravity would then be understood as a variation on the Casimir theme, in which background zero-point-energy pressures were again responsible.

Although Sakharov did not develop the concept much further, he did outline certain criteria such a theory would have to meet such as predicting the value of the gravitational constant G in terms of zero-point-energy parameters.

The approach to gravity outlined by Sakharov has recently been addressed in detail, and with positive results, again by the author. (7)

The gravitational interaction is shown to begin with the fact that a particle situated in the sea of electromagnetic zero-point fluctuations develops a "jitter" motion, or ZITTERBEWEGUNG as it is called.

When there are two or more particles they are each influenced not only by the fluctuating background field, but also by the fields generated by the other particles, all similarly undergoing ZITTERBEWEGUNG motion, and the inter-particle coupling due to these fields results in the attractive gravitational force.

Gravity can thus be understood as a kind of long-range Casimir force. Because of its electromagnetic underpinning, gravitational theory in this form constitutes what is known in the literature as an "already-unified" theory.

The major benefit of the new approach is that it provides a basis for understanding various characteristics of the gravitational interaction hitherto unexplained.

These include the relative weakness of the gravitational force under ordinary circumstances (shown to be due to the fact that the coupling constant G depends inversely on the large value of the high-frequency cutoff of the zero-point-fluctuation spectrum); the existence of positive but not negative mass (traceable to a positive-only kinetic-energy basis for the mass parameter); and the fact that gravity cannot be shielded (a consequence of the fact that quantum zero-point-fluctuation "noise" in general cannot be

shielded, a factor which in other contexts sets a lower limit on the detectability of electromagnetic signals).

As to where the ubiquitous electromagnetic zero-point energy comes from, historically there have been two schools of thought: existence by fiat as part of the boundary conditions of the universe, or generation by the (quantum-fluctuation) motion of charged particles that constitute matter.

A straightforward calculation of the latter possibility has recently been carried out by the author. (8)

It was assumed that zero-point fields drive particle motion, and that the sum of particle motions throughout the universe in turn generate the zero-point fields, in the form of a self-regenerating cosmological feedback cycle not unlike a cat chasing its own tail.

This self-consistent approach yielded the known zero-point field distribution, thus indicating a dynamic-generation process for the zero-point fields.

Now as to the question of why quantum theory. Although knowledge of zero-point fields emerged from quantum physics as that subject matured, Professor Timothy Boyer at City College in New York took a contrary view.

He began asking in the late sixties what would happen if we took classical physics as it was and introduced a background of random, classical fluctuating fields of the zero-point spectral distribution type. Could such an all-classical model reproduce quantum theory in its entirety, and might this possibility have been overlooked by the founders of quantum theory who were not aware of the existence of such a fluctuating background field?

(First, it is clear from the previously-mentioned cosmological calculation that such a field distribution would reproduce itself on a continuing dynamic basis.)

Boyer began by tackling the problems that led to the introduction of quantum theory in the first place, such as the blackbody radiation curve and the photoelectric effect. One by one the known quantum results were reproduced by this upstart neoclassical approach, now generally referred to as Stochastic Electrodynamics (SED) (9), as contrasted to quantum electrodynamics (QED).

Indeed, Milonni at Los Alamos noted in a review of the Boyer work that had physicists in 1900 thought of taking this route, they would probably have been more comfortable with this classical approach than with Planck's hypothesis of the quantum, and one can only speculate as to the direction that physics would have taken then.

The list of topics successfully analyzed within the SED formulation (i.e., yielding precise quantitative agreement with QED treatments) has now

been extended to include the harmonic oscillator, Casimir and Van der Waals forces and the thermal effects of acceleration through the vacuum, to name a few.

Out of this work emerged the reasons for such phenomena as the uncertainty principle, the incessant fluctuation of particle motion, the existence of Van der Waals forces even at zero temperature, and so forth, all shown to be due to the influence of the unceasing activity of the random background fields.

There are also some notable failures in SED, such as transparent derivation of something as simple as Schrodinger's equation, which turns out as yet to be an intractable problem.

Therefore, it is unlikely that quantum theory as we have come to know it and love it will be entirely replaced by a refurbished classical theory in the near future.

Nonetheless, the successes to date of the SED approach, by its highlighting of the role of background zero-point-fluctuations, means that when the final chapter is written on quantum theory, field fluctuations in empty space will be accorded an honored position.

And now to the preeminent question of all, where did the Universe come from? Or, in modern terminology, what started the Big Bang? Could quantum fluctuations of empty space have something to do with this also?

Well, Prof. Edward Tryon of Hunter College of the City University of New York thought so when he proposed in 1973 that our Universe may have originated as a fluctuation of the vacuum on a large scale, as "simply one of those things which happen from time to time." (10)

This idea was later refined and updated within the context of inflationary cosmology by Alexander Vilenkin of Tufts University, who proposed that the universe is created by quantum tunneling from literally nothing into the something we call our universe. (11)

Although highly speculative, these types of models indicate once again that physicists find themselves turning again and again to the Void (and the fluctuations thereof) for their answers.

Those with a practical bent of mind may be left with yet one more unanswered question. Can this emerging Rosetta Stone of physics be used to translate such lofty insights into mundane application?

Could the engineer of the future specialize in "vacuum engineering?" Could the energy crisis be solved by harnessing the energies of the zero-point sea?

After all, since the basic zero-point energy form is highly random in nature, and tending towards self-cancellation, if a way could be found to bring

order out of chaos, the, because of the highly energetic nature of the vacuum fluctuations, relatively large effects could in principle be produced.

Given our relative ignorance at this point, we must fall back on a quote given by Podolny (12) when contemplating this same issue.

"It would be just as presumptuous to deny the feasibility of useful application as it would be irresponsible to guarantee such application."

Only the future can reveal the ultimate use to which Mankind will put this remaining Fire of the Gods, the quantum fluctuations of empty space.

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CAN THE VACUUM BE ENGINEERED FOR SPACEFLIGHT APPLICATIONS?

OVERVIEW OF THEORY AND EXPERIMENTS

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Abstract

Quantum theory predicts, and experiments verify, that empty space (the vacuum) contains an enormous residual background energy known as zero-point energy (ZPE). Originally thought to be of significance only for such esoteric concerns as small perturbations to atomic emission processes, it is now known to play a role in large-scale phenomena of interest to technologists as well, such as the inhibition of spontaneous emission, the generation of short-range attractive forces (e.g., the Casimir force), and the possibility of accounting for sonoluminescence phenomena. ZPE topics of interest for spaceflight applications range from fundamental issues (where does inertia come from, can it be controlled?), through laboratory attempts to extract useful energy from vacuum fluctuations (can the ZPE be "mined" for practical use?), to scientifically-grounded extrapolations concerning "engineering the vacuum" (is "warp-drive" space propulsion a scientific possibility?). Recent advances in research into the physics of the underlying ZPE indicate the possibility of potential application in all these areas of interest.

Introduction

The concept "engineering the vacuum" was first introduced by Nobel Laureate T. D. Lee in his book Particle Physics and Introduction to Field Theory. As stated there: "The experimental method to alter the properties of the vacuum may be called vacuum engineering.... If indeed we are able to alter the vacuum, then we may encounter some new phenomena, totally unexpected." Recent experiments have indeed shown this to be the case.

With regard to space propulsion, the question of engineering the vacuum can be put succinctly: "Can empty space itself provide the solution?" Surprisingly enough, there are hints that potential help may in fact emerge quite

literally out of the vacuum of so-called "empty space." Quantum theory tells us that empty space is not truly empty, but rather is the seat of myriad energetic quantum processes that could have profound implications for future space travel. To understand these implications it will serve us to review briefly the historical development of the scientific view of what constitutes empty space.

At the time of the Greek philosophers, Democritus argued that empty space was truly a void, otherwise there would not be room for the motion of atoms. Aristotle, on the other hand, argued equally forcefully that what appeared to be empty space was in fact a plenum (a background filled with substance), for did not heat and light travel from place to place as if carried by some kind of medium?

The argument went back and forth through the centuries until finally codified by Maxwell's theory of the luminiferous ether, a plenum that carried electromagnetic waves, including light, much as water carries waves across its surface. Attempts to measure the properties of this ether, or to measure the Earth's velocity through the ether (as in the Michelson-Morley experiment), however, met with failure. With the rise of special relativity which did not require reference to such an underlying substrate, Einstein in 1905 effectively banished the ether in favor of the concept that empty space constitutes a true void. Ten years later, however, Einstein's own development of the general theory of relativity with its concept of curved space and distorted geometry forced him to reverse his stand and opt for a richly-endowed plenum, under the new label spacetime metric.

It was the advent of modern quantum theory, however, that established the quantum vacuum, so-called empty space, as a very active place, with particles arising and disappearing, a virtual plasma, and fields continuously fluctuating about their zero baseline values. The energy associated with such processes is called zero-point energy (ZPE), reflecting the fact that such activity remains even at absolute zero.

The Vacuum as a Potential Energy Source

At its most fundamental level, we now recognize that the quantum vacuum is an enormous reservoir of untapped energy, with energy densities conservatively estimated by Feynman and others to be on the order of nuclear energy densities or greater. Therefore, the question is, can the ZPE be "mined" for practical use? If so, it would constitute a virtually ubiquitous energy supply, a veritable "Holy Grail" energy source for space propulsion.

As utopian as such a possibility may seem, physicist Robert Forward at Hughes Research Laboratories demonstrated proof-of-principle in a paper published in 1984, "Extracting Electrical Energy from the Vacuum by Cohesion of Charged Foliated Conductors." Forward's approach exploited a

phenomenon called the Casimir Effect, an attractive quantum force between closely-spaced metal plates, named for its discoverer, H. G. B. Casimir of Philips Laboratories in the Netherlands. The Casimir force, recently measured with high accuracy by S. K. Lamoreaux at the University of Washington, derives from partial shielding of the interior region of the plates from the background zero-point fluctuations of the vacuum electromagnetic field. As shown by Los Alamos theorist Milonni and his colleagues, this shielding results in the plates being pushed together by the unbalanced ZPE radiation pressures. The result is a corollary conversion of vacuum energy to some other form such as heat. Proof that such a process violates neither energy nor thermodynamic constraints can be found in a paper by D. Cole and myself published in 1993 under the title "Extracting Energy and Heat from the Vacuum."

Attempts to harness the Casimir and related effects for vacuum energy conversion are ongoing in our laboratory and elsewhere. The fact that its potential application to space propulsion has not gone unnoticed by the Air Force can be seen in its request for proposals for the FY-1986 Defense SBIR Program. Under entry AF86-77, Air Force Rocket Propulsion Laboratory (AFRPL) Topic: Non-Conventional Propulsion Concepts we find the statement: "Bold, new non-conventional propulsion concepts are solicited.... The specific areas in which AFRPL is interested include.... (6) Esoteric energy sources for propulsion including the zero point quantum dynamic energy of vacuum space."

Several experimental formats for tapping the ZPE for practical use are under investigation in our laboratory. An early one of interest is based on the idea of a Casimir pinch effect in non-neutral plasmas, basically a plasma equivalent of Forward's electromechanical charged-plate collapse (see Puthoff, 1990). The underlying physics is described in a paper submitted for publication by myself and M. Piestrup, and it is illustrative that the first of several patents issued to a consultant to our laboratory, K. R. Shoulders, contains the descriptive phrase "... energy is provided... and the ultimate source of this energy appears to be the zero-point radiation of the vacuum continuum."

Another intriguing possibility is provided by the phenomenon of sonoluminescence, bubble collapse in an ultrasonically-driven fluid which is accompanied by intense, sub-nanosecond light radiation. Although the jury is still out as to the mechanism of light generation, Nobelist Julian Schwinger has argued for a Casimir interpretation. Possibly related experimental evidence for excess heat generation in ultrasonically-driven cavitation in heavy water is claimed in an EPRI Report by George and Stringham of E-Quest Sciences, although attributed to a nuclear micro-fusion process. Work is under way in our laboratory to see if this claim can be replicated.

Yet another proposal for ZPE extraction is described in a patent issued to Mead and Nachamkin. The approach proposes the use of resonant dielectric spheres, slightly detuned from each other, to provide a beat-frequency downshift of the more energetic high-frequency components of the ZPE to a more easily captured form. We are discussing the possibility of a collaborative effort between us to determine whether such an approach is feasible.

Finally, an approach utilizing micro-cavity techniques to perturb the ground state stability of atomic hydrogen is under consideration in our lab. It is based on a 1987 paper of mine in which I put forth the hypothesis that the nonradiative nature of the ground state is due to a dynamic equilibrium in which radiation emitted due to accelerated electron ground state motion is compensated by absorption from the ZPE. If this hypothesis is true, there exists the potential for energy generation by the application of the techniques of so-called cavity quantum electrodynamics QED. In cavity QED, excited atoms are passed through Casimir-like cavities whose structure suppresses electromagnetic cavity modes at the transition frequency between the atom's excited and ground states. The result is that the so-called "spontaneous" emission time is lengthened considerably (for example, by factors of ten), simply because spontaneous emission is not so spontaneous after all, but rather is driven by vacuum fluctuations. Eliminate the modes, and you eliminate the zero-point fluctuations of the modes, hence suppressing decay of the excited state. As stated in an April 1993 *Scientific American* review article on cavity QED, "An excited atom that would ordinarily emit a low-frequency photon cannot do so, because there are no vacuum fluctuations to stimulate its emission..." In its application to energy generation, mode suppression would be used to perturb the hypothesized dynamic ground-state absorption/emission balance to lead to energy release (patent pending).

An example in which Nature herself may have taken advantage of energetic vacuum effects is discussed in a model published by ZPE colleagues A. Rueda of California State University at Long Beach, B. Haisch of Lockheed-Martin, and D. Cole of IBM. In a paper published in the *Astrophysical Journal* in 1995, they propose that the vast reaches of outer space constitute an ideal environment for ZPE acceleration of nuclei and thus provide a mechanism for "powering up" cosmic rays. Details of the model would appear to account for other observed phenomena as well, such as the formation of cosmic voids. This raises the possibility of utilizing a "sub-cosmic-ray" approach to accelerate protons in a cryogenically-cooled, collision-free vacuum trap and thus extract energy from the vacuum fluctuations by this mechanism.

The Vacuum as the Source of Gravity and Inertia

What of the fundamental forces of gravity and inertia that we seek to overcome in space travel? We have phenomenological theories that describe their effects (Newton's Laws and their relativistic generalizations), but what of their origins?

The first hint that these phenomena might themselves be traceable to roots in the underlying fluctuations of the vacuum came in a 1967 study published by the well-known Russian physicist Andrei Sakharov. Searching to derive Einstein's phenomenological equations for general relativity from a more fundamental set of assumptions, Sakharov came to the conclusion that the entire panoply of general relativistic phenomena could be seen as induced effects brought about by changes in the quantum-fluctuation energy of the vacuum due to the presence of matter. In this view the attractive gravitational force is more akin to the induced Casimir force discussed above, than to the fundamental inverse square law force between charged particles with which it is often compared. Although speculative when first introduced by Sakharov, this hypothesis has led to a rich and ongoing literature (including a contribution of my own in 1989) on quantum-fluctuation-induced gravity, a literature that continues to yield deep insight into the role played by vacuum forces.

Given an apparent deep connection between gravity and the zero-point fluctuations of the vacuum, a similar connection must exist between these self-same vacuum fluctuations and inertia. This is because it is an empirical fact that the gravitational and inertial masses have the same value, even though the underlying phenomena are quite disparate. Why, for example, should a measure of the resistance of a body to being accelerated, even if far from any gravitational field, have the same value that is associated with the gravitational attraction between bodies? Indeed, if one is determined by vacuum fluctuations, so must the other.

To get to the heart of inertia, consider a specific example in which you are standing on a train in the station. As the train leaves the platform with a jolt, you could be thrown to the floor. What is this force that knocks you down, seemingly coming out of nowhere? This phenomenon, which we conveniently label inertia and go on about our physics, is a subtle feature of the universe that has perplexed generations of physicists from Newton to Einstein. Since in this example the sudden disquieting imbalance results from acceleration "relative to the fixed stars," in its most provocative form one could say that it was the "stars" that delivered the punch. This key feature was emphasized by the Austrian philosopher of science Ernst Mach, and is now known as Mach's Principle. Nonetheless, the mechanism by which the stars might do this deed has eluded convincing explication.

Addressing this issue in a 1994 paper entitled "Inertia as a Zero-Point Field Lorentz Force," Haisch, Rueda and I were successful in tracing the problem of inertia and its connection to Mach's Principle to the ZPE properties of the vacuum. In a sentence, although a uniformly moving body does not experience a drag force from the (Lorentz-invariant) vacuum fluctuations, an accelerated body meets a resistance (force) proportional to the acceleration. By accelerated we mean, of course, accelerated relative to the fixed stars. It turns out that an argument can be made that the quantum fluctuations of distant matter structure the local vacuum-fluctuation frame of reference (see Puthoff, "Source...", 1989). Thus, in the example of the train the punch was delivered by the wall of vacuum fluctuations acting as a proxy for the fixed stars through which one attempted to accelerate.

The implication for space travel is this: Given the evidence generated in the field of cavity QED (discussed above), there is experimental evidence that vacuum fluctuations can be altered by technological means. This leads to the corollary that, in principle, gravitational and inertial masses can also be altered.

The possibility of altering mass with a view to easing the energy burden of future spaceships has been seriously considered by the Advanced Concepts Office of the Propulsion Directorate of the Phillips Laboratory at Edwards Air Force Base. Gravity researcher Robert Forward accepted an assignment to review this concept. His deliverable product was to recommend a broad, multi-pronged effort involving laboratories from around the world to investigate the inertia model experimentally.

After a one-year investigation Forward finished his study and submitted his report to the Air Force, who published it under the title Mass Modification Experiment Definition Study. The Abstract reads in part:

".... Many researchers see the vacuum as a central ingredient of 21st-Century physics. Some even believe the vacuum may be harnessed to provide a limitless supply of energy. This report summarizes an attempt to ind an experiment that would test the Haisch, Rueda and Puthoff (HRP) conjecture that the mass and inertia of a body are induced effects brought about by changes in the quantum-fluctuation energy of the vacuum.... It was possible to find an experiment that might be able to prove or disprove that the inertial mass of a body can be altered by making changes in the vacuum surrounding the body."

With regard to action items, Forward in fact recommends a ranked list of not one but four experiments to be carried out to address the ZPF-inertia concept and its broad implications. The recommendations included investigation of the proposed "sub-cosmic-ray energy device" mentioned earlier, and the investigation of an hypothesized "inertia-wind" effect proposed

by our laboratory and possibly detected in early experimental work by Forward and Miller, though the latter possibility is highly speculative at this point.

Engineering the Vacuum for "Warp Drive"

Perhaps one of the most speculative, but nonetheless scientifically-grounded, proposals of all is the so-called Alcubierre Warp Drive. Taking on the challenge of determining whether Warp Drive a la Star Trek was a scientific possibility, general relativity theorist Miguel Alcubierre of the University of Wales set himself the task of determining whether faster-than-light travel was possible within the constraints of standard theory. Although such clearly could not be the case in the flat space of special relativity, general relativity permits consideration of altered spacetime metrics where such a possibility is not a priori ruled out. Alcubierre's further self-imposed constraints on an acceptable solution included the requirements that no net time distortion should occur (breakfast on Earth, lunch on Alpha Centauri, and home for dinner with your wife and children, not your great-great-great grandchildren), and that the occupants of the spaceship were not to be flattened against the bulkhead by unconscionable accelerations.

A solution meeting all of the above requirements was found and published by Alcubierre in *Classical and Quantum Gravity* in 1994. The solution discovered by Alcubierre involved the creation of a local distortion of spacetime such that spacetime is expanded behind the spaceship, contracted ahead of it, and yields a hypersurfer-like motion faster than the speed of light as seen by observers outside the disturbed region. In essence, on the outgoing leg of its journey the spaceship is pushed away from Earth and pulled towards its distant destination by the engineered local expansion of spacetime itself. (For follow-up on the broader aspects of "metric engineering" concepts, one can refer to a paper published by myself in *Physics Essays* in 1996.) Interestingly enough, the engineering requirements rely on the generation of macroscopic, negative-energy-density, Casimir-like states in the quantum vacuum of the type discussed earlier. Unfortunately, meeting such requirements is beyond technological reach without some unforeseen breakthrough, as emphasized by Pfenning and Ford in a recently submitted manuscript.

Related, of course, is the knowledge that general relativity permits the possibility of wormholes, topological tunnels which in principle could connect distant parts of the universe, a cosmic subway so to speak. Publishing in the *American Journal of Physics* in 1988, theorists Morris and Thorne initially outlined in some detail the requirements for traversible wormholes and have found that, in principle, the possibility exists provided one has access to Casimir-like, negative-energy-density quantum vacuum states. This has led to a rich literature, summarized recently in a 1996 book by Matt Visser of

Washington University, St. Louis. Again, the technological requirements appear out of reach for the foreseeable future, perhaps awaiting new techniques for cohering the ZPE vacuum fluctuations in order to meet the energy-density requirements.

Conclusions

We began this discussion with the question: "Can the vacuum be engineered for spaceflight applications?" The answer is: "In principle, yes." However, engineering-wise it is clear that there is a long way to go. Given the cliché "a journey of 1000 miles begins with the first steps," it is also clear that we can take those first steps now in the laboratory. Given that Casimir and related effects indicate the possibility of tapping the enormous residual energy in the vacuum-fluctuation ZPE, and the demonstration in cavity QED that portions of the ZPE spectrum can be manipulated to produce macroscopic technological effects such as the inhibition of spontaneous emission of excited states in quantum systems, it would appear that the first steps along this path are visible. This, combined with newly-emerging concepts of the relationship of gravity, inertia and warp drive to properties of the vacuum as a manipulable medium, indicate yet further reaches of possible technological development, although requiring yet unforeseen breakthroughs with regard to the possibility of engineering vacuum fluctuations to produce desired results.

Where does this leave us? As we peer into the heavens from the depth of our gravity well, hoping for some "magic" solution that will launch our spacefarers first to the planets and then to the stars, we are reminded of Arthur C. Clarke's phrase that highly-advanced technology is essentially indistinguishable from magic. Fortunately, such magic appears to be waiting in the wings of our deepening understanding of the quantum vacuum in which we live.

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THE NEW TESLA ELECTROMAGNETICS AND THE SECRETS OF FREE ELECTRICAL ENERGY

COMMENTS ON THE NEW TESLA ELECTROMAGNETICS

BY T. E. BEARDEN

A: Discrepancies in Present EM Theory

There are at least twenty-two major discrepancies presently existing in conventional electromagnetics theory. This paper presents a summary of those flaws, and is a further commentary on my discussion of scalar longitudinal waves in a previous paper, "Solutions to Tesla's Secrets and the Soviet Tesla Weapons," Tesla Book Company, 1981 and 1982.

I particularly wish to express my deep appreciation to two of my friends and colleagues who at this time, I believe, wish to remain anonymous. One of the two is an experimental genius who can produce items that do not work by orthodox theory.

The second is a master of materials science and electromagnetics theory. I thank them both for their exceptional contributions and stimuli regarding potential shortcoming in present electromagnetics theory, and their forbearance with the many discussions we have held on this and related subjects.

It goes without saying that any errors in this paper are strictly my own, and not the fault of either of my distinguished colleagues.

(1) In present electromagnetics theory, charge and charged mass are falsely made identical. Actually, on a charged particle, the "charge" is the flux of virtual particles on the "bare particle" of observable mass.

The charged particle is thus a "system" of true massless charge coupled to a bare chargeless mass. The observable "mass" is static, three-dimensional and totally spatial.

"Charge" is dynamic, four-dimensional or more, virtual and spatiotemporal.

Further, the charge and observable mass can be de-coupled, contrary to present theory. Decoupled charge -- that is, the absence of mass -- is simply what we presently refer to as

"Vacuum." Vacuum, spacetime, and massless charge are all identical.

Rigorously, we should utilize any of these three as an "ether," as suggested for vacuum by Einstein himself (see Max Born, Einstein's Theory of Relativity, Revised Edition, Dover Publications, New York, 1965, p. 224). And all three of them are identically anenergy -- not energy, but more fundamental components of energy.

(2) Electrostatic potential is regarded as a purely 3-dimensional spatial stress. Instead, it is the intensity of a many-dimensional (at least four-dimensional) virtual flux and a stress on all four dimensions of spacetime.

This is easily seen, once one recognizes that spacetime is identically massless charged. (It is not "filled" with charge; rather, it is charge!) Just as, in a gas under pressure, the accumulation of additional gas further stresses the gas, the accumulation of charge (spacetime) stresses charge (spacetime).

Further, if freed from its attachment to mass, charge can flow exclusively in time, exclusively in space, or in any combination of the two. Tesla waves -- which are scalar waves in pure massless charge flux itself -- thus can exhibit extraordinary characteristics that ordinary vector waves do not possess.

And Tesla waves have extra dimensional degrees of freedom in which to move, as compared to vector waves. Indeed, one way to visualize a tesla scalar wave is to regard it as a pure oscillation of time itself.

(3) Voltage and potential are often confused in the electrostatic case, or at least thought of as "composed of the same thing." For that reason, voltage is regarded as "potential drop." This also is not true.

Rigorously, the potential is the intensity of the virtual particle flux at a single point -- whether or not there is any mass at the point -- and both the pressure and the point itself are spatiotemporal (4-dimensional) and not spatial (3-dimensional) as presently assumed.

Voltage represents the spatial intersection of the difference in potential between two separated spatial points, and always implies at least a miniscule flow of mass current (that is what makes it spatial!).

"Voltage" is spatial and depends upon the presence of observable mass flow, while scalar electrostatic potential is spatiotemporal and depends upon the absence of observable mass flow. The two are not even of the same dimensionality.

(4) The charge of vacuum spacetime is assumed to be zero, when in fact it is a very high value. Vacuum has no mass, but it has great massless charge and virtual particle charge flux. For proof that a charged vacuum is the seat of something in motion, see G. M. Graham and D. G. Lahoz, "Observation of static electromagnetic angular momentum in vacuo," Nature, Vol. 285, 15

May 1980, pp. 154-155. In fact, vacuum IS charge, identically, and it is also spacetime, and at least four-dimensional.

(5) Contrary to its present usage, zero is dimensional and relative in its context. A three-dimensional spatial hole, for example, exists in time. If we model time as a dimension, then the spatial hole has one dimension in 4-space.

So a spatial absence is a spatiotemporal presence. In the vacuum 4-space, a spatial nothing is still a something. The "virtual" concept and mathematical concept of a derivative are simply two present ways of unconsciously addressing this fundamental problem of the dimensional relativity of zero.

(6) The concepts of "space" and "time" imply that spacetime (vacuum) has been separated into two parts. We can only think of a space as "continuing to exist in time." To separate vacuum spacetime into two pieces, an operation is continually required.

The operator that accomplishes this splitting operation is the photon interaction, the interaction of vector electromagnetic energy or waves with mass.

I have already strongly pointed out this effect and presented a "raindrop model" or first-order physical change itself in my book, *The Excalibur Briefing*, Strawberry Hill Press, San Francisco, 1980, pp. 128-130.

(7) "Vector magnetic potential" is assumed to be always an aspect of (and connected to) the magnetic field. In fact it is a separate, fundamental field of nature and it can be entirely disconnected from the magnetic field. See Richard P. Feynman et al, *The Feynman Lectures on Physics*, Addison-Wesley Publishing Co., New York, 1964, Vol. II, pp. 15-8 to 15-14.

Curiously, this fact has been proven for years, yet it has been almost completely ignored in the West. The "(triangle)x" operator, when applied to the A-field, makes B-field.

If the (triangle)x operator is not applied, the "freed" A-field possesses much-expanded characteristics from those presently allowed in the "bound" theory. Specifically, it becomes a scalar or "shadow vector" field; it is not a normal vector field.

(8) The speed of light in vacuum is assumed to be a fundamental constant of nature. Instead it is a function of the intensity of the massless charge flux (that is, of the magnitude of the electrostatic potential) of the vacuum in which it moves. (Indeed, since vacuum and massless charge are one and the same, one may say that the speed of light is a function of the intensity of the spatiotemporal vacuum!).

The higher the flux intensity (charge) of the vacuum, the faster the speed of light in it. This is an observed fact and already shown by hardcore measurements.

For example, distinct differences actually exist in the speed of light in vacuo, when measured on the surface of the earth as compared to measurements in space away from planetary masses. In a vacuum on the surface of the earth, light moves significantly faster. For a discussion and the statistics, see B. N. Belyaev, "On Random Fluctuations of the Velocity of Light in Vacuum," Soviet Physics Journal, No. 11, Nov. 1980, pp. 37-42 (original in Russian, translation by Plenum Publishing Corporation.)

The Russians have used this knowledge for over two decades in their strategic psychotronics (energetics) program; yet hardly a single U.S. scientist is aware of the measured variation of c in vacuo. In fact, most Western scientists simply cannot believe it when it is pointed out to them!

(9) Energy is considered fundamental and equivalent to work. In fact, energy arises from vector processes, and it can be disassembled into more fundamental (anenergy) scalar components, since the vectors can.

These scalar components individually can be moved to a distant location without expending work, since one is not moving force vectors. There the scalar components can be joined and reassembled into vectors to provide "free energy" appearing at a distance, with no loss in between the initial and distant points.

For proof that a vector field can be replaced by (and considered to be composed of) two scalar fields, see E. T. Whittaker, Proceedings of the London Mathematical Society, Volume 1, 1903, p. 367. By extension, any vector wave can be replaced by two coupled scalar waves.

(10) The classical Poynting vector predicts no longitudinal wave of energy from a time-varying, electrically charged source. In fact, an exact solution of the problem does allow this longitudinal wave. See T. D. Keech and J. F. Corum, "A New Derivation for the Field of a Time-Varying Charge in Einsteins Theory," International Journal of Theoretical Physics, Vol. 20, No. 1, 1981, pp. 63-68 for the proof.

(11) The present concepts of vector and scalar are severely limited, and do not permit the explicit consideration of the internal, finer-grained structures of a vector or a scalar. That is, a fundamental problem exists with the basic assumptions in the vector mathematics itself.

The "space" of a vector field, for example, does not have inter-nested sublevels (subspaces) containing finer "shadow vectors" or "virtual vectors." Yet particle physics has already discovered that electrical reality is built that way. Thus one should actually use a "hypernumber" theory after the manner of Charles Muses.

A scalar is filled with (and composed of) nested levels of other "spaces" containing vectors, where these sum to "zero" in the ordinary observable frame without an observable vector resultant.

In Muses' mathematics, for example, zero has real roots. Real physical devices can be -- and have been -- constructed in accordance with Muses' theory. For an introduction to Muses' profound hypernumbers approach, see Charles Muses' forward to Jerome Rothstein, *Communication, Organization and Science, The Falcon's Wing Press, Indian Hills, Colorado, 1958*. See also Charles Muses', "Applied Hypernumbers: Computational Concepts," *Applied Mathematics and Computation, Vol. 3, 1976*. See also Charles Muses' "Hypernumbers II", *Applied Mathematics and Computation, January 1978*.

(12) With the expanded Tesla electromagnetics, a new conservation of energy law is required. Let us recapitulate for a moment. The oldest law called for the conservation of mass.

The present law calls for the conservation of "mass and energy", but not each separately. If mass is regarded as simply another aspect of energy, then the present law calls for the conservation of energy.

However, this assumes that energy is a basic, fundamental concept. Since the energy concept is tied to work and the movement of vector forces, it implicitly assumes "vector movement" to be a "most fundamental" and irreducible concept.

But as we pointed out, Whittaker showed that vectors can always be further broken down into more fundamental coupled scalar components. Further, Tesla discovered that these "coupled components" of "energy" can be individually separated, transmitted, processed, rejoined, etc.

This directly implies that energy per se need not be conserved. The new law therefore calls for the conservation of anenergy, the COMPONENTS OF ENERGY.

These components may be coupled into energy, and the energy may be further compacted into mass. It is the sum total of the (anenergy) components -- coupled and uncoupled -- that is conserved, NOT the matter or the energy per se.

Further, this conservation of anenergy is not spatial; rather it is spatiotemporal in a spacetime of at least four or more dimensions.

(13) Relativity is presently regarded as a theory or statement about fundamental physical reality. In fact, it is only a statement about FIRST ORDER reality -- the reality that emerges from the vector interaction of electromagnetic energy with matter.

When we break down the vectors into scalars (shadow vectors or hypervectors), we immediately enter a vastly different, far more fundamental reality.

In this reality superluminal velocity, multiple universes, travel back and forth in time, higher dimensions, variation of all "fundamental constants" of nature, materialization and dematerialization, and violation of the "conservation of energy" are all involved.

Even our present Aristotlean logic -- fitted to the photon interaction by vector light as the fundamental observation mechanism -- is incapable of describing or modeling this more fundamental reality. Using scalar waves and scalar interactions as much subtler, far less limited observation/detection mechanisms, we must have a new "superrelativity" to describe the expanded electromagnetic reality uncovered by Nikola Tesla.

(14) "Charge" is assumed to be quantized, in addition to always occurring with -- and locked to -- mass. Indeed, charge is not necessarily quantized, just as it is not necessarily locked to mass. Ehrenhaft discovered and reported fractional charges for years, in the 30's and 40's, and was ignored. See P.A.M. Dirac, "Development of the Physicist's Conception of Nature", Symposium on the Development of the Physicist's Conception of Nature, ed. Jagdish Merha, D. Reidel, Boston, 1973, pp. 12-14 for a presentation of some of Ehrenhaft's results.

Within the last few years Stanford University researchers have also positively demonstrated the existence of "fractional charge." For a layman's description of their work, see "A Spector Haunting Physics," Science News, Vol. 119, January 31, 1981, pp. 68-69.

Indeed, Dirac in his referenced article points out that Millikan himself -- in his original oil drop experiments -- reported one measurement of fractional charge, but discounted it as probably due to error.

(15) Presently, things are always regarded as traveling through normal space. Thus we use or model only the most elementary type of motion -- that performed by vector electromagnetic energy. We do not allow for things to "travel inside the vector flow itself."

Yet, actually, there is a second, more subtle flow inside the first, and a third, even more subtle flow inside the second, and so on. We may operate inside, onto, into, and out of energy itself -- and any anenergy component of energy.

There are hypervectors and hyperscalars unlimited, within the ordinary vectors and scalars we already know. Further, these "interlan flows" can be engineered and utilized, allowing physical reality itself to be directly engineered, almost without limits.

(16) We always assume everything exists in time. Actually, nothing presently measured exists in time, because the physical detection/measurement process of our present instruments destroys time, ripping it off and tossing it away -- and thereby "collapsing the wave function."

Present scientific methodology thus is seriously flawed. It does not yield fundamental (spacetime) truth, but only a partial (spatial) truth. This in turn leads to great scientific oversights.

For example, mass does not exist in time, but mass x time (masstime) does. A fundamental constant does not exist in time, but "constant x time" does. Energy does not exist in time, but energy x time (action) does. Even space itself does not exist in time -- spacetime does.

We are almost always one dimension short in every observable we model. Yet we persist in thinking spatially, and we have developed instruments that detect and measure spatially only. Such instruments can never measure and detect the phenomenology of the nested substrata of time.

By using scalar technology, however, less limited instruments can indeed be constructed -- and they have been. With such new instruments, the phenomenology of the new electromagnetics can be explored and an engineering technology developed.

(17) We do not recognize the connection between nested levels of virtual state (particle physics) and orthogonally rotated frames (hyperspaces). Actually, the two are identical, as I showed in the appendix to my book, *The Excalibur Briefing*, Strawberry Hills Press, San Francisco, 1980, pp. 233-235.

A virtual particle in the laboratory frame is an observable particle in a hyperspatial frame rotated more than one orthogonal turn away. This of course implies that the hyperspatial velocity of all virtual particles is greater than the speed of light.

The particle physicist is already deeply involved in hyperspaces and hyperspatial charge fluxes without realizing it. In other words, he is using tachyons (particles that move faster than light) without realizing it.

(18) Presently quantum mechanics rigorously states that time is not an observable, and therefore it cannot be measured or detected. According to this assumption, one must always infer time from spatial measurements, because all detections and measurements are spatial.

With this assumption, our scientists prejudice themselves against looking for finer, subquantal measurement methodologies and instrumentation. Actually this present limitation is the result of the type of electromagnetics we presently know, where all instruments (the "measurers") have been interacted with by vector electromagnetic energy (light).

Every mass that has temperature (and all masses do!) is continually absorbing and emitting photons, and in the process they are continually connecting to time and disconnecting from time. If time is continually being carried away from the detector itself by its emitted photons, then the detector cannot hold and "detect" that which it has just lost.

With Tesla electromagnetics, however, the fundamental limitation of our present instruments need not apply. With finer instruments, we can show there are an infinite number of levels to "time", and it is only the "quantum level time" which is continually being lost by vector light (photon) interaction.

By using subquantal scalar waves, instruments can move to deeper levels of time -- in which case the upper levels of time ARE measureable and detectable, in contradistinction to present assumptions.

(19) In the present physics, time is modeled as, and considered to be, a continuous dimension such as length. This is only a gross approximation. Indeed, time is not like a continuous "dimension," but more like a series of "stiches," each of which is individually made and then ripped out before the next stitch appears.

"Vector light" photons interact one at a time, and it is this interaction with mass that creates quantum change itself. The absorption of a photon - which is energy \times time -- by a spatial mass converts it to masstime: the time was added by the photon.

The emission of a photon tears away the time, leaving behind again a spatial mass. It is not accidental, then, that time flows at the speed of light, for it is light which contains and carries time. It is also not accidental that the photon IS the individual quantum.

Since all our instruments presently are continually absorbing and emitting photons, they are all "quantized," and they accordingly "quantize" their detections. This is true because all detection is totally internal to the detector, and the instruments only detect only their own internal changes.

Since these detections are on a totally granular quantized background, the detections themselves are quantized. The Minkowski model is fundamentally erroneous in its modelling of time, and for that reason relativity and quantum mechanics continue to resist all attempts to successfully combine them, quantum field theory notwithstanding.

(20) Presently, gravitational field and electrical field are considered mutually exclusive. Actually this is also untrue.

In 1974, for example, Santilli proved that electrical field and gravitational field indeed are not mutually exclusive. In that case one is left with two possibilities: (a) they are totally the same thing, or (b) they are partially the same thing. For the proof, see R. M. Santilli, "Partons and Gravitation: Some Puzzling Questions," *Annals of Physics*, Vol. 83, No. 1, March 1974.

With the new Tesla electromagnetics, pure scalar waves in time itself can be produced electrically, and electrostatics (when the charge has been separated from the mass) becomes a "magic" tool capable of directly affecting anything that exists in time -- including the gravitational field. Antigravity and the inertial drive are immediate and direct consequences of the new electromagnetics.

(21) Presently, mind is considered metaphysical, not a part of physics, and not affected by physical means. Literally, the prevailing belief of Western scientists is that man is a mechanical robot -- even though relativity depends entirely upon the idea of the idea of the "observer."

Western science today thus has essentially become dogmatic, and in this respect borders on a religion. Since this "religion," so to speak, is now fairly well entrenched in its power in the state, Western science is turning itself into an oligarchy.

But mind occupies time, and when we measure and affect time, we can directly measure and affect mind itself. In the new electromagnetics, then, Man regains his dignity and his humanity by restoring the reality of mind and thought to science. In my book, *The Excalibur Briefing*, I have already pointed out the reality of mind and a simplified way in which it can be modeled to the first order.

With scalar wave instruments, the reality of mind and thought can be measured in the laboratory, and parapsychology becomes a working, engineering, scientific discipline.

(22) Multiple valued basic dimensional functions are either not permitted or severely discouraged in the present theory. For one thing, integrals of multiple valued derivative functions have the annoying habit of "blowing up" and yielding erroneous answers, or none at all. And we certainly do not allow multiple types of time!

This leads to the absurdity of the present interpretation of relativity, which permits only a single observer (and a single observation) at a time. So if one believes as "absurd" a thing as the fact that more than one person can observe an apple at the same time, the present physics fails.

However, the acceptance of such a simple proposition as multiple simultaneous observation leads to a physics so bizarre and incredible that most Western physicists have been unable to tolerate it, much less examine its consequences.

In the physics that emerges from multiple simultaneous observation, all possibilities are real and physical.

There are an infinite number of worlds, orthogonal to one another, and each world is continually splitting into additional such "worlds" at a stupendous rate. Nonetheless, this physics was worked out by Everett for

his doctoral thesis in 1956, and the thesis was published in 1957. (See Hugh Everett, III, *The Many-Worlds Interpretation of Quantum Mechanics: A Fundamental Exposition*, with papers by J. A. Wheeler, B. S. DeWitt, L. N. Cooper and D. Van Vechten, and N. Graham; eds. Bryce S. Dewitt and Neill Graham, Princeton Series in Physics, Princeton University Press, 1973.)

Even though it is bizarre, Everett's physics is entirely consistent with the present experimental basis of physics. The present electromagnetic theory is constructed for only a single "rod" or universe -- or "level."

The expanded theory, on the other hand, contains multiply nested levels of virtual state charge -- and these levels are identically the same as orthogonal universes, or "hyperframes."

Multiple kinds -- and values -- of time also exist. The new concept differs from Everett's, however, in that the orthogonal universes intercommunicate in the virtual state.

That is, an observable in one universe is always a virtual quantity in each of the other universes. Thus one can have multi-level "continuities" and "discontinuities" simultaneously, without logical conflict.

It is precisely these levels of charge -- these levels of scalar vacuum -- that lace together the discontinuous quanta generated by the interaction of vector light with mass.

However, to understand the new electromagnetic reality, one requires a new, expanded logic which contains the old Aristotlean logic as a subset. I have already pointed out the new logic in my paper, "A Conditional Criterion for Identity, Leading to a Fourth Law of Logic," 1979, available from the National Technical Information Center, AD-A071032.

Even as logic is extended, quantum mechanics, quantum electrodynamics, and relativity are drastically changed by the Tesla electromagnetics, as I pointed out in my paper, "Solutions to Tesla's Secrets and the Soviet Tesla Weapons," Tesla Book Company, 1580 Magnolia, Millbrae, CA, 94030, 1980.

The present electromagnetics is just a special case of a much more fundamental electromagnetics discovered by Nikola Tesla, just as Newtonian physics is a special case of the relativistic physics.

But in the new electromagnetics case, the differences between the old and the new are far more drastic and profound.

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In support of Dr. Boren, one should point out that the "positive" end of circuits can simply be "less negative" than the "negative" end. In other words, the circuit works simply from higher accumulation of negative charges (the "negative" end) to a lesser accumulation of negative charges (the "positive" end).

Nowhere need there be positive charges (protons, positrons, etc.) to make the circuit work. Dr. Borens theory, though dramatic at first encounter, nonetheless bears close and meticulous examination -- particularly since he has been able to gather experimental data which support his theory and disagree with present theory.

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B: The Secret of Electrical Free Energy

Present electromagnetic theory is only a special case of the much more fundamental electromagnetic theory discovered by Nikola Tesla at the turn of the century.

Pure vacuum is pure charge flux, without mass. The vacuum has a very high electrical potential -- something on the order of 200 million volts, with respect to a hypothetical zero charge.

Thus in an ordinary electrical circuit, each point of the "ground" -- which has the same potential as the vacuum -- actually has a non-zero absolute potential.

This circuit ground has a value of zero only with respect to something else which has the same absolute electrical potential.

Voltage, which is always associated with a flow of electrical "mass" current (even if only a miniscule flow), is, by definition, a difference dropped in potential when a charge mass moves between two spatially separated points.

What we have termed "electrical current" only flows where there is a suitable conducting medium between things which have a difference in absolute potential.

Furthermore, between any two points in any material, there is considered to be a finite resistance -- if we apply a voltage and have a mass current flowing between the two points!

Rigorously, to have one of the three is to have them all. To lose one is to lose all three. Immediately we see a major error in present theory: One can have a "difference in scalar potential" between two points without having a "voltage drop" between them.

Specifically, if no mass current flows between them, no resistance exists between them, and no voltage drop exists between them.

In the same fashion, one can have a "scalar wave" through the vacuum without a voltage wave. In that case, the wave has no E-field and no H-field.

The only reason one has an E field around a statically charged object is because the charged electrons accumulated on the object are actually in violent motion. It is this motion of the charged masses that produces E-field -- as well as H-field whenever that entire E-field ensemble moves through laboratory space.

Now let us reason together the "approximate" manner utilized in present electromagnetic theory. For example, let us examine a bird sitting on a high tension line.

The bird sits on the high tension line without a flow of mass electricity, because there is no significant difference in potential drop between the bird and the line. Specifically, between the bird's two feet -- each in contact with a different portion of the line -- there exists no potential difference.

This is true even though, with respect to the vacuum, each foot is at a potential that would be "100,000 volts higher," were a mass current flowing. And it is true even though the absolute potential of each foot may be some 200.1 million "volts," were a mass current flowing.

Now an interesting thing happens to the bird when he flies through the air to light upon the high tension wire. As he flies towards the wire, he is flying through the massless electrostatic potential field of the wire, for that field extends an infinite distance away from the wire.

The electrostatic potential field -- pure O-field -- is actually the spatiotemporal intensity of the massless charge at a point. In other words, as the bird flies to the wire, he flies into an increasing "massless charge" potential, building up to 100,000 "volts" higher than the earth.

However, very little (if any) "mass flow" potential difference is experienced upon his body in approaching the wire, and so essentially no "charged mass currents" are induced in his body.

Thus the little flier safely navigates into the teeth of a very high electrostatic potential, lights upon the wire, and is not "fried" in the process.

When he lights on the wire, his body has reached the electrostatic potential that each foot's contact point has.

Again, there is no mass current flow. But his body is immersed in an increased flux of massless charge -- which is what the electrostatic potential represents. And each "virtual particle" flow in that charge represents a "massless (scalar)" electrical current.

The point is, one can have any amount of massless charge flow -- "scalar" current -- without any mechanical work being done in the system.

All electrical work in a circuit is done against the physical mass of the charged masses that flow. Rigorously, force is defined as the time rate of change of momentum. Even in the relativistic case where $F = ma + v(dm/dt)$, change of momentum requires mass movement. No mechanical work, and hence no energy, is expended by massless charge flow.

That is why the vacuum massless charge -- which is composed of a very high flux of massless "particles" -- normally does no work on our systems, and expends none of its very high "potential energy."

It is exactly the same as the bird which flew into an increasing scalar field as it approached the high tension wire -- no work was done upon the bird by the increasing scalar flux currents encountered by its body.

By existing "in the vacuum," so to speak, we (the whole earth) are as birds sitting on a high tension line! Until we create a significant difference in potential, via our present electromagnetic circuits, no current can flow -- anywhere.

Even if we produce potential differences, we must have a conductor and charged masses to flow, if we wish to produce mechanical work. Presently our electromagnetic theory allows us to create a difference in potential within different parts of a circuit, but only by moving and shifting charged mass.

We therefore have to do work on this electrical mass in moving it around, and we only get back the work we have put into the circuit. In other words, presently all we do is "pump" electrical mass.

Now notice what would happen to the bird on the line if we substantially "pulsed" the potential on the line. Suppose we "pulsed" it such that the bird's physical system -- considered as a circuit containing a capacitance, a resistance, an inductance, and many free electrons -- became resonant to the pulsing frequency.

In that case the "bird system" would resonate, and a great deal of electrical mass would surge back and forth in the body of the bird. In the bird's body, voltage would exist, charged mass current would flow, work would be done, and the bird would be electrocuted.

Also, note that, without mass movement, electromagnetic vector fields are not produced (and a portion of the difficulty lies with the actual vector mechanics itself). Scalar (nonvector) waves continually penetrate the "space" where there is no mass movement.

This means there can exist a "delta-0" without a voltage or an E-field. The present theory does not allow this, because it always uses "q" (charge) to be charged mass. Briefly, without belaboring the point, let us just say that is the mechanical spin of the individual charged particle -- such as the electron -- which "entangles" or "knits together" or "couples" independent scalar waves into vector waves.

A vector wave is simply two coupled scalar waves. The entire force field concept -- such as the E-field and the B-field -- is operationally defined in terms of the force exhibited on a test particle, or test mass.

Rigorously, an E-field does not exist as a force field in a vacuum, but as two coupled scalar 0-fields "tumbling about each other." When these two coupled, tumbling fields meet a spinning electron, e.g., the force emerges on the electron mass. In short, movement of a rotating mass changes delta-0 to "voltage", creating the V/I/R triad.

By "accumulating charged mass particles" -- such as electrons -- one certainly can increase the value of 0, which represents the charge intensity or "scalar electrostatic potential." However, that is not the only way to increase it.

Resonance and rotation of charged mass can also be appropriately employed to vary the vacuum charge potential 0, under proper circumstances.

By the correct application of rotary principles and Tesla electromagnetic theory, it is possible to oscillate -- and change the vacuum potential itself, in one part of an electrical system.

Thus by correct procedures a part of a system can be electrically altered so that the absolute value of its "ground" (vacuum) potential differs significantly from the normal vacuum-ground state.

THE FINAL SECRET OF FREE ENERGY

BY T. E. BEARDEN

Foreword

This paper contains the real secret of tapping the vacuum energy very simply, using almost any source of potential (battery, electrostatic generator a la the Swiss electrostatic device (the Testatika), elevated wire w/250 V/m in the earth/ionosphere potential, etc.).

The objective is for the moderately technical reader to understand how to build and understand not only a single device, but also hundreds of different kinds of them. While it is quite simple, the "magic principle" contained in this paper only took me some 30 years to discover.

The precise definitions necessary to understand the free energy rationale are included. Also included are some very simple pseudo equations for the process. Do not underestimate these simple pseudo equations __ they tell the tale that's needed.

Also, there has been little or no time to "dress up" the paper. It's simply written down very informally, to get the necessary points across.

Nearly everything fundamental that we've been taught about EM energy is wrong or incomplete. Even the definition of energy in physics is wrong! Let me summarize a few of the things that are wrong with the classical electromagnetics (CEM) model as follows:

CEM is still utilizing a model based on a material ether. Although the Michelson-Morley experiment destroyed the material ether assumption in 1887, the classical EM model has never been corrected. It also contains no definition of charge, and no definition of potential. In many cases, algorithms to calculate a magnitude are baldfacedly and erroneously advanced as "definitions."

CEM still prescribes the force fields as the causes of all EM phenomena; it has been known since 1959 that forces are effects and not causes, that EM force fields exist only in and on the charged particles of mass in the physical system, and that the potentials are the primary causes of EM phenomena.

The lack of definitive definitions of mass and force in mechanics is carried over into EM theory; there is no adequate definition of EM force or of EM mass. The magnitude of the electrical charge on an electron is not quantized. Instead, it is discretized, being a function of the magnitude of

the virtual photon flux (VPF) exchange between the vacuum and the charged particle.

When the charged particle is placed in a potential that differs from ambient, then the magnitude of the VPF and hence the magnitude of the electric charge on the electron is altered. The CEM assumption of an "empty vacuum" is totally falsified by modern quantum mechanics.

The CEM notion that EM force fields and force field waves exist in vacuum is totally false. Only potentials and potential gradients exist in the vacuum. EM waves in vacuum are not forcefield waves as CEM prescribes; instead, they are oscillations of potentials and potential gradients.

Potentials have a bidirectional EM wave-pair structure, where the bidirectional wave pairs are phaselocked in a harmonic series. In each wave pair, photons and antiphotons are continually coupling (into spin-2 gravitons) and decoupling. This is where gravitation and electromagnetics are unified.

The CEM notion that singular EM forces exist in either matter or the vacuum is false; Newton's third law requires that all forces exist in opposite pairs. Not a single one of the equations universally taught as "Maxwell's equations" ever appeared in any book or paper by James Clerk Maxwell; instead, they are Oliver Heaviside's equations.

Maxwell's actual theory was written in quaternions, which is a complete system of mathematics. The Heaviside/Gibbs vector version

- (1) has a lower topology,
- (2) is not a complete system of mathematics, and
- (3) actually captured only a subset of Maxwell's actual theory.

Tensor theory does not recapture that which was lost. There are even more errors in CEM, but these should suffice to make the point: Classical electromagnetics theory is seriously flawed, with archaic foundations, riddled with errors, and it should be completely redone.

Until this revamping of CEM is accomplished, the present model solidly blocks free energy, antigravity, a unified physical field theory, and a unified theory of mind and matter interaction.

A second paper this year will detail the exact long-term causative mechanism for cancer and leukemia, and the exact mechanism for essentially 100% cure of terminal tumors in laboratory animals, demonstrated by the Priore team in France in the late 1960s and early 1970s. The same mechanism can be used to cure AIDS.

Throughout the world, humankind is suffering. In the poor populations of the world, early death is the norm, as is frequent famine. One third of the human race goes to bed hungry each night. Protein starvation of children is common. One third of the human race is infected with worms.

Many other diseases ravage the farflung poor peoples of the world. They have little or no industries. They have no abundant electrical power. They have little education, and little modern knowledge. They have little or no medical treatment. In short, they are born without hope; live in misery, filth, disease, and poverty, and die without dignity.

Meanwhile, the factories, cities, and enclaves of the "developed and developing" worlds belch forth fumes, toxic and hazardous wastes, and pollutants. They also spew forth weaponry which for one reason or another is used to arm the poorer nations, for use in destroying themselves and their impoverished neighbors. Warfare, terror, banditry, despotism, and all the four horsemen of the Apocalypse are truly loosed in the earth.

We simply must do better than that. And we can do better than that! But to do better, we've got to make the basics available to impoverished nations, cheaply and easily. Primary among their needs are energy and medical treatment. Given those, populations can be stabilized, people educated, development begun, and the living standard drastically elevated. So that is the immediate goal.

In this paper, I am freely giving away what required me an arduous 30 years of my life to discover. Shortly we will also detail the new methodology for a new therapeutic science, hopefully to cure the diseases that ravage humanity.

God willing, this paper will trigger a thousand, or even ten thousand, scientists and engineers to develop overunity energy devices. If so, shortly we can rid our biosphere of noxious automobile and factory exhausts, radioactive nuclear wastes, and massive oil spills.

We can remove many of the hydrocarbon combustion pollutants from the air, stop acid rain and the destruction of our forests, and stop the steady rise of carbon monoxide in our air. If that truly tends toward a "Greenhouse" effect, then we can halt that effect as well.

The Creator has always given us bountiful free electrical energy, everywhere, easily and readily for the simple taking. It has only been our own blindness and folly that have prevented us from seeing and using this free energy bounty.

So here is the final secret of abundant, free electrical energy.

Please use the knowledge well and see that its benefits also accrue to those impoverished ones who need it so desperately. Remember the adage, "Inasmuch as you have done it to these little ones..." This is for those little ones. You are our brothers and sisters. We want you to live. And we want you to have a better quality of life, not just bare existence. We care.

Tom Bearden February 9, 1993

Some Definitions

The Quantum Mechanical Vacuum: First we need some definitions. We start by assuming the quantum mechanical vacuum.(1) Empty "spacetime" is filled with an incredibly intense flux of virtual particles. It is a plenum, not an emptiness. We shall be interested only in the fantastic flux of virtual photons, for we are discussing electromagnetics.

Energy and Potential: Energy is any ordering, either static or dynamic, in the virtual particle flux of vacuum. EM energy is any ordering, either static or dynamic, in the virtual photon flux (VPF) of vacuum. That is, for a particular kind of "field" energy, we simply choose the so-called quantum particle of that field, and consider only that kind of virtual particle flux.

Potential is any ordering, either static or dynamic, in the virtual particle flux of vacuum. Hey! That's exactly the same definition as energy. Quite correct. Energy and potential are identically the same. Neither is presently defined correctly in physics.

Energy is normally defined as "Energy is the capacity to do work." That's totally false. Energy has the capacity to do work, because work is correctly defined as the dissipation (disordering; scattering) of energy (order).

The scattering of energy is work. It is not energy! I.e., energy is not definable as its own scattering!

Look at it this way: A man has the capacity to catch fish. That is true, but it is not a definition, since a definition must in some sense be an identity. You cannot say that a man is the capacity to catch fish! That may be a submitted definition, all right, but it is false. Similarly, energy has the capacity to do work; that is one of its attributes. But energy IS the ordering in the VPF (we are referring from now on primarily only to EM).

Scalar and Vector Potentials: The scalar potential is any static (with respect to the external observer) ordering in the VPF of vacuum. The vector potential is any dynamic (with respect to the external observer) ordering in the VPF of vacuum. We shall be interested in the electrostatic scalar potential. So it is a static ordering __ a stationary template __ in the VPF of vacuum, much as a whirlpool is a stationary ordering (template, form) in the rushing flow of a river.

The Scalar Potential Has An Internal Structure

The Structure of the Scalar Potential: According to rigorous proofs by Whittaker(2) and Ziolkowski,(3) any scalar potential can be mathematically decomposed into a harmonic series of bidirectional wave pairs. [Figure 1] shows this Whittaker/Ziolkowski (WZ) structure. In each pair, the

forward-time wave is going in one direction, and its phase conjugate (time-reversed) replica wave is going in the other.

According to the so-called distortion correction theorem(4) of nonlinear phase conjugate optics, this PCR wave must precisely superpose spatially with its partner wave in the pair. The two waves are in-phase spatially, but 180 degrees out of phase in time.

The wave is made of photons, and the antiwave (PCR wave) is made of antiphotons. It follows that, as wave and antiwave pass through each other, the photons and antiphotons are coupling and uncoupling with each other, because the antiphoton is a PCR photon, and PCR's precisely superpose spatially with their partner.

A photon or antiphoton has wave characteristics, because it has a frequency; if the wave aspects are perfectly ordered and perfectly correlated, then so are the photon's particle aspects.

A Potential Is An Ordering Across the Universe: So we have __ astoundingly __ perfect VPF inner ordering infolded in the electrostatic scalar potential! We also have perfect wave/antiwave ordering infolded in there.

When you collect a simple set of charges on a small ball or in a region, the scalar EM potential from that set of charges reaches across the universe. In it you have an infinite harmonic series of phase-locked time-forward EM waves going out from the charges to all distant points of the entire universe. And you have an infinite harmonic series of phase-locked time-reversed EM waves coming from all points of the universe, back to the "collected charges" source.

A Potential Is A River of Energy: The point is, you have established a mighty, hidden, 2-way river of energy between that collection of charges and every other point in the universe. There is infinite energy in each of those infolded waves and antiwaves.

But in a localized region, the energy density in each wave is finite. Since in finite circuits the potential interacts with a localized set of mass, we shall be concerned with the local energy density (joules/coulomb) of the potential.

But forget the conventional myth of visualizing the potential as pushing a unit charge in from infinity "against the force field" __ there isn't any force field in the vacuum, as is well-known in quantum mechanics. Also, Newton's third law requires all forces to occur in pairs __ each pair consisting of a force and its 3rd law reaction force.

From that viewpoint alone, there is no such thing as an EM forcefield or forcefield wave in the vacuum. There are just gradients of the vacuum potential present in the vacuum. In the vacuum, an EM wave is

actually a wave of the phase locked gradients of the electrostatic scalar potential and of the magnetostatic scalar potential. And each such gradient wave is simultaneously accompanied by its phase conjugate gradient wave, because of Newton's third law.

Newton's third law requires forces to occur in pairs of equal but antiparallel forces.

Both wave and antiwave co-exist simultaneously in the vacuum EM wave.(5) Therefore it's a stress potential wave, not a force field wave. It's more like an electromagnetic sound wave,(6) and so it is a longitudinal wave, not a transverse wave.

In the EM vacuum wave's interaction with matter (the so-called "photon" interaction), the wave-half normally interacts with the electron shells of the atom, giving translation forces, while the anti-wave half interacts with the atomic nucleus, giving the Newtonian 3rd law reaction (recoil) forces (waves). The EM wave in vacuum is an electrogravitational wave.

Energy Is Internally Infinite and Unlimited: A static potential __ which is identically excess energy __ is internally dynamic and infinite. Energy is internally infinite and unlimited! But it has a finite energy density in a local region of space time.

Since energy interacts with matter locally, we shall be concerned with the local energy density (joules per coulomb).

A Principle of Great Importance: The only way you can have a "chunk" or finite amount of energy to dissipate in a circuit as work is to first have a potential's local energy density interact with a local finite mass collector. The normal interacting mass collector is the free electrons (the free electron gas) in the circuit.

You can have, e.g., (joules/coulomb x coulomb); (joules/gram x grams); (joules/m³ x m³); etc.

Voltage, Force, Potential Gradients, Loads, and Work: Now let's look at circuitry aspects. Conventionally they are a mess. Voltage is "essentially" defined as the "drop in potential." In other words, it's the dissipation (disordering) of a "finite amount" of potential gradient. But the only way you can get a "finite amount" of infinite energy/potential gradient is by first interacting the potential gradient's internal, finite, excess energy density with a finite "collector" mass. E.g., (joules/coulomb available for collection) x (coulombs collecting) = excess joules collected on the interacting coulombs, available for dissipation.

So voltage is really the dissipation of a finite collection of excess EM energy/potential gradient. The dissipation of potential or of its gradient is not potential! You cannot logically define either potential or energy as it's own dissipation!

We presently use the notion of "voltage" in two completely contradictory ways in electrical physics. Here's how we got the confusion: We take a potential gradient (which has a local energy density), and we "collect" it across some charged masses in a locality — usually the free electrons in the free electron gas in our circuitry. That is, we express the finite energy density of the potential gradient (before collection onto charges) in the local region in terms of energy per coulomb.

The potential gradient actually is a change to the ambient potential, and so it contains an excess energy density (the magnitude may be either positive or negative). We then collect this potential (actually this potential density) on a certain number of coulombs, which places tiny little gradients of potential across (coupled to) each free electron. The local excess energy density of the potential gradient multiplied by the amount of collecting mass gives the amount of excess energy collected (on the interacting charges/coulombs).

On each collecting particle, that little gradient, together with the coupling particle, constitutes a tiny force. F is not just equal to ma (non relativistic case); instead, $F = (ma)$, where (mass x acceleration) is considered as a unitary, inseparable thing. So that little potentialized electron (that little EM force) moves itself around the circuit. In the load (scatterer), the little potentialized electron (the little force) is subjected to jerks and accelerations, thus radiating energy (shucking its gradient). Since this is done in all directions in the scatterer (load), that gets rid of the gradient, reducing the "little force" (potentialized electron) to zero because the little potential gradient is lost due to radiation.

Collecting And Dissipating Energy

Energy Dissipation and Collection: Without further ado, we consider the scalar potential's local energy density in terms of joules per coulomb. That is, in a specific glob of charges (i.e., in finite circuits), the amount of energy collected from a potential gradient onto the finite number of charges receiving/collecting it, is equal to the number of joules of energy per coulomb that is in the potential gradient, times the number of coulombs collecting (receiving) the potential gradient. The current is the activated (potentialized) coulombs per second that dissipate their potential gradients during that second. The current multiplied by the time the current flows gives the activated coulombs that dissipated their activation (potentialization) during that flow time. Dissipating, activated coulombs multiplied by the excess energy collected per activated coulomb gives the energy dissipated (the work or scattering done) in the load.

We define collection as the connection of a potential gradient (a source) to the charged masses in a circuit element (the element is called the collector), which for a finite delay time does not allow its potentialized free electrons to move as current.

In the collector, during this delay time these trapped electrons are "activated" by potential gradients being coupled to them.

Technically, that delay time in the collector is known as relaxation time,(7) in the case of the free electron gas(8) (in a wire or in a circuit element). A collector then is a circuit element that has a usable, finite relaxation time.

During that relaxation time, the trapped electrons are potentialized without movement as current; each collecting/receiving free electron gets a little gradient across it, but no current yet flows. In other words, during this finite relaxation time (collection time), we extract potential from the source, but no current.

Thus we extract energy (potential), but no power (which is voltage x amperage). During the relaxation time, we extract from the source only a flow of VPF, which is continually replaced in the source by the vacuum's violent VPF exchange with the source's bipolarity charges.

We do not extract power from the battery/source during relaxation time, but we extract free energy density. That free energy density, coupling with a finite quantity of electrons, gives us a collected finite amount of energy. With that background, let's start again, and go through this in a useful "free energy" manner.

The Electron Gas. We refer to the conventional model of the free electron gas in a wire.(9) Although the electrons in this gas actually move by quantum mechanical laws and not by classical laws, we shall simply be dealing with the "on the average" case.

So we will speak of the electrons and their movement in a classical sense, rather than a quantum mechanical sense, as this will suffice very well for our purposes.

When one connects a circuit to a source of potential gradient (say, to a battery), the first thing that happens nearly instantly is that the potential gradient races onto the coupling wire and heads down it at almost the speed of light. As it goes onto the wire, this gradient "couples" to the free electrons in the free electron gas.

However, inside the wire these electrons can hardly move down the wire at all; they can only "slip" once in a while, yielding a "drift" velocity of a fraction of a cm/sec.(10) On the surface, things are just a little bit different. Most of the "current" in a wire, as is well-known, moves along the surface, giving us the "skin" effect. [For that reason, many cables are stranded of finer

wires, to provide more skin surface per cm³ of copper, and hence more current-carrying capability per cm³ of copper.]

So initially little gradients of potential appear on and across each free electron, with a single little electrostatic scalar potential [V₀] appearing on each electron, and coupled to it. The couplet of V₀ x Me, where Me is the mass of the electron, constitutes a small deltaEe. [This is rigorous; the conventional EM notion that an E field exists in the vacuum is absurd, and it is well-known in QM that no observable force field exists in the vacuum. As Feynman pointed out, only the potential for the force field exists in the vacuum,(11) not the force field as such. Or as Lindsay and Margenau pointed out in their Foundations of Physics, one does not have an observable force except when observable mass is present.12].

We have stated it even stronger:

Not only is $F = ma$, but $F = -ma$ (nonrelativistic case).(13) (the term $=$ in the paper is actually 3 stacked parallel lines) Since no observable mass exists in vacuum, then no observable F exists there either.

Force, Coupled Gradients, and Electron Translation

Electrons Coupled to a Potential Gradient Move Themselves. The point is, when activated by a "coupled potential gradient," the activated electron moves itself until it loses its activation (its coupled potential gradient).

Let me say that again, in a little more detail. Forget the standard notion that a force field such as the E-field causes electrons to move. Also forget the notion that the E-field is given by $E = -V_0$ (where 0 is the electrostatic scalar potential).

In foundations of physics, those equations are known to be incorrect for the vacuum. EM force fields are known (in QM foundations theory) to be effects, existing only in and on the charged particles, and not existing separately at all,(14) or in the vacuum at all.(15) Instead of $E = -V_0$, in the vacuum the correct equation would be something like this: $PE = -V_0$.

In this case, we have correctly stated that the potential gradient PE provides the potential for producing an antiparallel E-field in and on a coupling/collecting charged mass, and the magnitude and direction of that potential gradient will be given by $-V_0$, if and only if a charged mass particle is first introduced so that it couples to PE.

At any rate, the activated/potentialized electron moves itself. The reason is that it constitutes a force. Force = (mass x acceleration) (non relativistic case) (again, the symbol $=$ is 3 stacked parallel bars). So the potentialized/activated electron is continuously accelerating. However, it is prevented from easily moving down the wire directly. To begin to do that, it essentially has to first move to the outer skin of the copper conductor.

The Collector: We now consider a circuit element that we called a collector. (It could be a special coil made of special material, a capacitor with doped plates rather than simple conducting plates, or any one of a number of things).

The objective is for the collector to be made of special material so that it has a free electron gas whose electrons are momentarily not free to move as current (they continue to move violently around microscopically, but essentially with zero net macroscopic translation) for a finite delay (relaxation) time, while they are settling themselves upon the surface and preparing to move as current.

Let's call the electrons NNT (no net translation electrons) during that finite delay (relaxation time). During that "no-current" delay time, the NNT electrons become potentialized/activated by the potential gradient impressed across the collector. So at the end of the NNT time, the NNT electrons are potentialized, and each is of the form $[V_0 \times Me]$.

The Secret of Free Energy

Two Circuits/Two Cycles: We are going to use two circuits and two cycles, as shown in [Figure 2]:

(1) We shall connect a collector to a primary source of potential (to a battery) during the short time that current does not yet flow, but potential does. (In other words, during the relaxation time of the collector, we allow the VPF to flow onto the NNT electrons of the collector and potentialize (activate) them, but do not yet allow the electrons themselves to flow as current, but only to move transversely in the wiring and collector.)

This is cycle one of a 2cycle process: This is collection of a specific amount of current-free potential gradient __ power-free energy __ off the potential-source (the battery) onto a collector. During the collection cycle/time, current does not and must not flow (we are discussing the ideal case). We are freely "charging up" the collector as a secondary battery/source.

(2) At the end of the collection (potentialization / activation) time/cycle in circuit one, the potentialized collector (the charged secondary source) is sharply switched away from its connection to the primary potential source (the battery), and at the same time it is instantly switched into a separate closed circuit with the load. This is important: In cycle two, the potentialized collector (with its finite amount of excess trapped EM energy) and the load are connected in a completely separate circuit, and one that is closed, with no connection at all to the original source of potential (in this case, to the battery). Specifically, this "load and potentialized collector"

circuit is completely separate from the primary source; during cycle two the primary source (the battery) is not connected to anything.

In other words, all we've taken from the primary source (the battery) is current-free, force-field-free potential gradient. So to speak, we've taken a "chunk of potential gradient" from the source, nothing else. You simply multiply the potential gradient's local energy density (the so-called "voltage", which is really excess joules per coulomb) by the number of coulombs of charge that is "activated" (that "collects" this voltage or excess joules/coulomb) in the collector.

Specifically, we have not taken any power from the battery itself, and so we have not done any internal work inside the battery upon its internal resistance, by a "closed circuit electron flow" back into the battery. We have not permitted such a flow.

Instead, we are using the activated collector as a temporary, secondary battery. We will utilize this secondary battery in a conventional manner to power the load, which will also kill the secondary battery (dissipate its trapped EM energy). But that will not affect the primary source. The primary source is never used to directly power the load. It is only used as an infinite source of potential gradient (i.e., as an infinite source of energy density).

The Standard Power Extraction Circuit

The Conventional Circuit: We digress momentarily: In the standard electrical method, the potential source (which is a bipolarity) is connected across the load. This connects both the external load and the internal resistance of the battery itself in series, as the "total circuit load." Electrons then pour through the external load circuit and through the internal battery resistance, from the "electron rich" polarity of the source to its "electron poor" opposite polarity.

The scattering of energy in the internal battery resistance is actually doing work to upset the chemistry that is maintaining the battery's charge separation (the bipolarity). In this manner the source's separation of charges (which is the "gate" furnishing the potential/energy gradient) is being destroyed as the current flows, and this in turn destroys the source of the potential gradient.

In other words, normally we engineers are trained to kill the bipolarity, which kills the potential source itself! Incredible as it may be, we engineers and scientists have been trained to utilize the free "trapped EM energy" furnished by nature through the source, to destroy the source of the energy/potential, with the same vigor as we power the external load! In fact, our teachers themselves simply have never learned any other way to do it except this deliberately "self-destructive" manner!

A Waterwheel Analogy

Imagine, if you will, a waterwheel that powers a mill, with a sluice gate upstream in a river, that diverts some river water into the sluice carrying water to the wheel when the sluice gate is opened into the river. The diverted water flows down to the waterwheel, turning it, and the spent water is fed back into the river below the millsite.

Now what fool would connect a pulley onto the waterwheel, with a rope running from the pulley to the sluice gate, so that when the wheel rotated, part of the rotational power also was utilized to close the sluice gate and shut off the water, stopping the waterwheel? If one did so, when the sluice gate was opened, the waterwheel would rotate only until the sluice gate was closed, shutting off the water. Then one would laboriously have to pay to reopen the sluice gate again, then again, then again.

No self-respecting "waterwheel engineer" would do such an unthinkable, insane thing. But that's exactly what we engineers, electrical physicists, and scientists have been trained to do! We have no energy engineers or energy scientists at all; instead, we have all been power engineers and power scientists. We have all been energy source killers!

In this paper we shall try to do better, and rectify "one of the most remarkable and inexplicable aberrations of the scientific mind which has ever been recorded in history," as Tesla called the conventional electromagnetics.¹⁶ By being energy engineers, we shall only have to pay for our energy source once, and then we shall draw as much energy from it as we wish.

External Load Power Is Free; Only The Power In The Source Costs

Here's the magic secret of free electrical power: The power in the external load is absolutely free, and it always has been free.⁽¹⁷⁾ In any load circuit the only power you have to pay for, and have ever had to pay for, is the power you incorrectly use to kill your own primary source. The only power that "costs" more effort/dollars is the power erroneously utilized inside the source to "close the gate" and kill the primary source.

Your electric power company doesn't pay for any of the collected energy on your load circuits that is dissipated to power your house.

Instead, the power company charges you for its own ignorance. It charges you for its insane use of its own freely extracted electrical energy to continually kill the bipolarity in each of its generators, thus continually killing the free electrical source of that generator's energy.⁽¹⁸⁾

In any electric circuit, we can continue to indefinitely power the external load indirectly from a source, so long as we are not so naive as to use any

of the free energy we extract from the primary source to dissipate back inside the primary source itself and shut it off!

And we can easily and freely multiply electrical potential. As an example, given a single good source of potential, a hundred radial wires can be connected to the source. The same potential will now appear at each of the ends of the hundred wires.

A switcher/collector unit can then operate from each radial line's end, and power external loads, without "loading" the original primary source. This "cascading" can be continued indefinitely. A single power plant, e.g., can power the entire electrical grid of the United States. And a single automobile battery can power a large, agile, electric automobile at highway speeds, with sports car acceleration, with unlimited range, without "refueling," and with no noxious chemical exhaust.

Obvious Impacts

Environmentalists should immediately see that the chemical pollution of the biosphere by mechanistic processes to obtain energy can be dramatically reduced, to almost negligible levels. There need be no huge oil tanker spills, for there need be no huge oil tankers.

There need be no worrisome radioactive wastes from nuclear power plants, or abandoned hazardous nuclear plants when their life is finished, because there need be no nuclear power plants. There need be no noxious exhausts from jet air planes (which are really what is diminishing the ozone layer and punching holes in it), automobiles, trucks, buses, innumerable coal-fired and oil-fired power plants, etc.

The Electronic Smog Problem

In fairness we point out that, as the usage of free electrical energy mushrooms, we will be dramatically increasing the low-level EM signal density of the environment, and that too is biologically detrimental. Although beyond the scope of this paper, that cumulative biological damage mechanism has also been uncovered by this author. A formal paper is presently in preparation for presentation in March 1993 at the annual meeting and conference of the Alabama Academy of Science.(19)

The paper will also present an entirely new definition of cancer, give its exact long-term cumulative mechanism, and give an exact, scientifically proven mechanism for eliminating cancer, leukemia, and other debilitating diseases such as AIDS. For our purposes here, we simply state that we understand the EM "electronic smog" biological damage mechanism, and how to go about developing a total counter for it. Eventually we would see a

small "counter unit" added to each power unit, alleviating the "electronic smog" problem and preventing biological damage.

Only Dissipate Energy From a Collector, Not the Source

Completion of the Collection Cycle: But to return to the completion of our collection cycle (cycle one). During collection, we have not extracted power from the source. That is vital. We have not moved the gate through which our source is furnishing free energy. We have not diminished our primary source. From our previous definitions of potential, we have indeed extracted trapped energy from the primary source, because we placed its "local energy density" across a certain finite collector/mass, instead of extracting power (dissipating energy inside the source or battery to spoil its chemistry and deplete its charge separation.).

All Energy Is Free

Here's the incredible truth. The entire universe is filled with mind boggling free energy everywhere, in the simplest of things.

Simply scrape your feet on the carpet, and you will collect perhaps 2,000 "volts" on your body. At that time, hidden EM energy is flowing from every point in the universe to your body, and from your body back to every point in the universe. We know that all macroscopic matter is filled with stupendous amounts of electrical charge. So an incredible river of energy -- a great flux -- is driving every single thing, from the smallest to the largest.

Opening a gate to extract trapped EM energy is simple. Just collect a bit of charge, or scrape your feet hard, or comb your hair briskly. All we have to do is not be stupid and close the gate once we've got it opened!

God has been most kind. We have nothing but free energy everywhere. All energy is furnished to us freely! It's our own blindness that has made us into energy source killers. All we have to do is open our eyes to the truth of nature's incredible energy bounty. We must just freely collect that bountiful fruit from Nature's tree, instead of chopping down the tree and killing it.

Dissipating The Collected Energy

The Work Cycle: We focus again on cycle two. Shortly after the now-potentialized collector is connected to the load at the beginning of cycle 2 (the power cycle, or energy dissipation cycle, or work cycle), the potential gradient across the potentialized collector is connected (transferred) across the free electrons in the bad circuit. We assume that the material of the collector and the switching time have been designed so that, shortly after switching to the loading/work cycle, the activated/potentialized free

electrons in the electron gas in the collector reach the skin of the collector, and are free to move as current.

So just after the beginning of cycle two, each of the free electrons in the load circuit now is potentialized and free to move down the wiring. Each potentialized (activated) electron has its own little individual potential gradient across it and coupled to it, due to the overall potential gradient from the collector. Remember, prior to coupling to charges, this potential gradient moves through the circuit at light speed.

An EM potential gradient coupled to a charged mass constitutes an EM force field (excess trapped EM energy per coulomb, times the number of collecting coulombs). Now each little free electron with its potential gradient forms a little E-field (force/charge), and that little E-field (force/charge) is free to move. That's all it takes to move (accelerate) the little activated electron's mass through the load (the scatterer).

We strongly stress that the potentialized/activated electron moves itself. It doesn't care whether or not the external battery is attached or not. It is its own little motorboat, with its own little engine driving it.

As the little potentialized electrons reach the load (the scatterer), they bang and clang around in there erratically. That is, the "scatterer" (load) causes spurious accelerations ("scatterings") of these self-driven electrons. As is well-known, when a charge is accelerated, it radiates photons. What actually happens is that these little "jerked around" electrons shuck off their little potential gradients in the load (in the scatterer, or the "jerk-arounder") by emitting/radiating photons in all directions. Hence the heat that is produced in the load; the heat is just these scattered photons. The theory of calorimetry already states that all the excess energy (on the potentialized electrons) will be dissipated as this heat (scattered EM energy).

When all the potentialized electrons have radiated away their potential gradients in the load (scatterer), they are no longer potentialized. The free electron gas is again "quiescent" and no longer potentialized/activated (again, we are talking about "on the average" from a classical viewpoint.).

Repetition and Review

Notice What We've Done: We took some trapped EM energy density (a chunk of potential gradient, a "voltage" before current flows) from the source, by switching that potential gradient (energy density, which is joules per coulomb) onto a collector (containing a certain number of coulombs of trapped charges) where the potential gradient activates/potentializes/couples-to these temporarily non translating electrons.

So the finite collector collected a finite amount of excess energy [joules/coulomb x collecting (trapped) coulombs] on its now-excited (activated) free electrons. Then before any current has yet flowed from the source, we switched that potentialized collector (with its temporarily restrained but potentialized electrons; with their finite amount of excess trapped EM energy) away from the source and directly across the load.

Shortly thereafter, the relaxation time in the collector expires. The potentialized electrons in the collector are freed to move in the external load circuit, consisting of the collector and the load, and so they do so. The scattering "shock collisions" due to the erratic electron accelerations in the load shake off the little potential gradients on the conduction electrons, emitting photons in all directions, which we call "heat." In shaking off the photons, the electrons lose their little potential gradients, hence lose their activation (excess EM energy).

Rigorously we have extracted some energy in trapped form, and allowed it to dissipate in the load, "powering the load" for a finite discharge/dissipation time and doing work.(20) Contrary to the conventional electrical power engineering, we have also done this without doing any work inside the source to diminish its ability to furnish potential gradient.

Additional Comment From Bearden

The present classical CEM model prescribes closed, energy-conservative type systems. If any electrical device works totally according to the accepted CEM model, it cannot and will not ever produce overunity. Simply put, you have excluded any hidden EM source that is freely replenished, and you have assumed continual killing of all energy input sources utilized. On the other hand, if one takes the view that the overunity electrical machines are possible after all, then -- whether one is consciously aware of it or not -- one has implied that classical CEM must somehow be substantially flawed. If it's flawed, then -- being a model -- some of its primary assumptions (postulates) and/or fundamental definitions must be in error.

The proper place to go after "free electrical energy" is to rigorously examine CEM, over and over, until flaws are uncovered which allow a hidden, freely replenished source of input energy. In other words, one must find a way to "open" the electrical system to an in flow of energy from this source, without closing off the source.

Until one finds such an "extension" of CEM, one has no model or concept which can reasonably be expected to provide overunity electrical energy output. Note also that, while the majority of the EM circuitry of an electrical overunity machine may obey CEM, at least one section -- where the source is freely tapped and the excess energy extracted -- must violate CEM.

I have spent many arduous years in this very process, right or wrong. The bottom line of my search is this: the only verified (by Whittaker and Ziolkowski) (WZ) "freely replenished river" of EM energy, that can act as the required "free energy" source for input to the would-be overunity electrical system, is the potential. But to understand the potential, completely new definitions are required for many entities, among them being energy, electrical charge, electrostatic scalar potential, voltage, etc. The present so-called "definitions" of these entities in CEM are either non-existent, entirely wrong, or quite unsatisfactory.

So far, the search has uncovered two major ways to tap the continually-replenished EM energy in the scalar EM potential:

(1) use of the inner WZ internal biwave structure of the potential as pump waves on/to a nonlinear material (such as the atomic nucleus), so that the nucleus becomes a pumped phase conjugate mirror. Then, by normal phase conjugate optical theory, simply inputting a small signal wave will produce an amplified phase conjugate replica (PCR) wave emitted from the mirror material, and this PCR will precisely backtrack the original input signal wave's path (see the distortion correction theorem) back out of the nucleus, out of the atom, and into the external circuit.

There, the amplified PCR wave can be "filtered off" and sent to the external load, to power the load. The Floyd Sweet vacuum triode works precisely by this mechanism. Note particularly that Barrett has shown that higher topology EM (such as the original quaternion EM theory) can accomplish such "optical functioning" without the use of optical materials.

To do Sweet's vacuum triode type process is thus theoretically possible with electrical circuitry alone, but one must have more than the current understanding of CEM, as Barrett pointed out. In other words, one can "open" any 4-space system by adding hyperspace (or subspace, if one insists on retaining Minkowski 4-space). One can thus have a hyperspatial source. Indeed, Ziolkowski and others have already pointed out that the WZ type decomposition of the scalar potential is essentially equivalent to having complex sources.

(2) The second way is to "trap the electron gas electrons" in a separate collector, feed "current-free potential" to the collector from a primary battery or other source of potential, and collect a bunch of excess energy (potential) in the collector's "penned up free electron 'horses'" waiting to carry the excess energy to the load and dissipate it there, once they have been released.

Then, one switches the primary potential source away from the collector, while the "energy-loaded horses" are still trapped and straining at the bit, so that no work can be done -- by those agitated horses when they stampede out

of there -- on the internal resistance of the primary source, to destroy or reduce it.

In the same switching action, the collector with its "snorting but still trapped electron horses" is switched across the load to form a totally separate circuit with it, having nothing at all to do with the original primary source of potential. Then, the agitated horses are released, and thunder out through the load, scattering their riders (excess energy) in all directions in the load, producing work/heat and powering the load. They will also charge on around to the reverse side of the collector, and kill its charge separation (kill its potential) as well, just as does any ordinary circuit.

The major disadvantage of method 1, as we presently have seen it done (however, check Barrett's demonstration that Tesla's patented circuitry is capable of doing it by circuitry alone), is that time-reversed electrical energy is produced. So Method 1 has some serious drawbacks. "Time-reversed energy stuff", which should stay in the atomic nucleus as Newtonian 3rd law reactions and 3rd-law energy exchanges, is dragged out.

Unusual effects on biological systems can occur. Antigravity effects can occur. Other hidden processes in the universes, that affect the atomic nucleus, can be gated into the external circuitry, causing disaster. Monopoles can be deposited in the magnets, causing them to explode like hand grenades. Most of the new "massive time-reverse energy" phenomenology is still unknown.

One cannot at this stage of ignorance adequately guarantee human safety. I presently don't see just how this kind of energy can pass an Underwriter Laboratories' testing and certification, until a lot more exhaustive work is done to understand the new phenomenology.

Method 2, however, yields ordinary, garden-variety, positive-time electrical energy. The method presented in the paper is my own discovery. No unusual time-reversed phenomena are involved. It would appear to be eminently practical to produce and certify power units based on Method 2. The phenomenology and risks are the same as for ordinary, time-forward power systems.

Method 2 has another unique characteristic: as a system, all the subsystems are already in the literature and validated. They have just not previously been put together in this fashion. So development of the system really represents an "integration" problem only, after one first does a little development of a proper degenerate semiconductor material (DSM).

In other words, one first develops (and tests) the exact doping materials and percentage, to get a DSM material that is still a good conductor but has a relaxation time of __ say __ one tenth of a millisecond. One builds the wires from the battery to the collector out of this new DSM material. If one uses a

capacitor for the collector, the plates must be made out of the new DSM material, not out of normal "pure conductor" material.

Then one develops a switcher that switches in one tenth (or less) the relaxation time of the DSM, or in this case in one hundredth of a millisecond. That switching time, of course, is easy for any decent electronic technician or electronic engineer.

One also develops a timing circuit that will

(1) sense the status of the discharge of the collector energy through the load, and

(2) trigger the switching at the correct times so that a smooth two-cycle (collect, discharge) process results. Note that the lengths of cycle one and cycle two are not necessarily equal at all. One may use multiple collectors/loads simultaneously, cascaded collectors/loads, etc. Hundreds of variations are possible and feasible.

It is not possible to do anything with this discovery in a normal manner. I would dearly like to be economically independent, so I could work full time in my efforts on free energy, antigravity, extended EM healing, cancer, etc. Many orthodox scientists will also fiercely resist this upstart notion of "overunity" electrical machines to the bitter end. When powerful economic interests realize one has such things for real, one is certainly going to be stopped, jailed, or killed, or he may just "mysteriously vanish" and never be seen again.

So I just freely released and distributed my discovery of method 2, in the paper "The Final Secret of Free Energy". It is deliberately targeted toward technicians, junior engineers, and educated laymen. (The principles and definitions raised, however, can be debated to the nth degree by knowledgeable foundation scientists). The paper has already been distributed worldwide. Now the principles and definitions are available to everyone. If they are in error, shortly that will be proven in spades. If they are correct, that will also be established shortly.

Anyone who wishes can develop and patent a particular application. There's no longer any way to stop this information from being disseminated and utilized. I hope that a flurry of development and patenting activity will result around the world. Get cheap, clean electrical energy to everyone. Bring on the electric auto, clean up the noxious auto exhausts, get rid of giant oil spills, and clean up the biosphere.

WHAT IS ENERGY IN AN ELECTRIC CIRCUIT?

Energy in an Electric Circuit: Here's the principle loud and clear.

Energy in an electric circuit involves only the potentialization and depotentialization of the electron carriers in that circuit.(21) It involves only the potential gradient (the joules per coulomb) collected by the circuit to potentialize its electrons, and the number of coulombs of electrons that are potentialized during the collection phase.

Electric circuits simply utilize electrons as carriers of "potential gradients," from the source to the load, where these gradients and the activated electrons constitute excess trapped EM energy. In the "shocking/scattering" occurring in the load, the jerking (acceleration) of the electrons causes these activated (trapped-energy-carrying) electrons to shuck off their potential gradients by emitting them as scattered photons (heat).

If one is thoughtless enough to allow the primary potential source to remain in the circuit during the "work" phase, then one is using the potentialized electrons to also go back into the primary source and scatter energy from its internal resistance (in ternal load), thereby disorganizing the organization that was producing the source potential and energy in the first place.

If one does that, then all the while one is getting some work (scattering of energy) in the load, one is also steadily getting some work done inside the primary source to steadily destroy it! Literally one is killing the goose that lays the golden eggs.

Continued Operations: But back to our circuit. After we complete one full collection/discharge cycle, we wish to continue producing work in the external load. So we simply switch the collector back away from the load and onto the primary source, collect some more current-free potential, and again independently switch the collector with its repotentialized free electrons back across the load.

We can repeat this two-cycle process to potentialize the external load and power it as long as we wish, from a battery or other source of potential, and never take any power at all from the primary battery. We do not need to drain the battery or source at all, in order to power a load, unless we attempt to power it directly. Powering the external load is always free!

Nature has been most kind, and we have been most ignorant. You can have all the trapped electrical energy you wish, from any source of potential, for free. You can power all the external loads you wish, for free, by using a collector as a secondary source, and simply shuttling potential between the

primary source and the collector. (22) But you cannot have power for free from (in) the potential source. If you allow current flow in your collection cycle, you are depleting the separated charges inside the battery that are furnishing the source potential.

The Coal-Fired Locomotive

Rigorous Analogy of a Coal-Fired Locomotive. Now here's an exact analogy, to assist in understanding. Imagine a coal-fired train, and a fireman shoveling coal. He has an external load/scatterer of energy (the fire in the firebox under the boiler).

He has a primary source of potential/energy (the coal car). No fireman in his right mind would ignite the coal in the chute of the coal bin, to try and get some heat energy into the firebox! [That is, he would not attempt to extract power from the source. Yet that's exactly what all we engineers are trained to do at present.]

Instead, the fireman takes out (collects) a finite amount (a shovelful) of coal (trapped energy). Coal per se (the potential gradient) has a certain energy density per unit volume (trapped joules per unit volume of coal) and the shovel (collector) has a certain volume. Accordingly, the shovelful of coal contains a certain amount of trapped joules of energy.

In the fireman's shovel (the collector), the energy remains in total ly trapped form, as coal not afire and without its trapped energy being dissipated as work. [He doesn't act like a fool and ignite the coal in the shovel either!] He then throws that shovel of coal (collected trapped energy) onto the fire (scatterer), completely separately from the coal bin/source. He continues to repeat his shoveling cycle, and each shovelful of coal added to the fire dissipates additional energy, powering the load.

The Free Energy Principle

All potential gradient (trapped excess energy density) is free for the taking.(23) The potential is due to the violent VPF exchange between the vacuum and the separated bipolar charges furnishing the source potential gradient. The energy of the entire universe is flowing through that source potential. You can have as much of this internal VPF flux energy (potential) as you wish, as often as you wish, so long as you don't demand current (which is power, or the rate at which the energy is being freed and dissipated.). It's really simple. You can have all the trapped energy you wish, from any source. You cannot connect to the source and start to dissipate the energy as power, however, without starting to close the "gate" from which your free trapped energy is coming.

In other words, here's the iron rule: If you draw current, you kill the bipolarity gate furnishing the potential gradient (source of energy density). In that case, you kill the source. If you do not draw current, you do not kill the bipolarity gate and you do not shut down the source. In that case, you can continue to "use" it and extract trapped EM energy from it forever.

Definitions Again

Definitions: I'll put down some simple equations, that may help to explain it more exactly. First we repeat some definitions.

Energy is any ordering imposed upon the virtual particle flux of vacuum. EM energy is any ordering imposed upon the virtual photon flux of vacuum. Static energy is an ordering (a template) which is stationary with respect to the external observer.

Dynamic energy is an ordering (a template) which is stationary with respect to the external observer.

Potential: Any ordering imposed upon the virtual particle flux of vacuum. Scalar potential is an ordering (template) that is not moving with respect to the external observer. Vector potential is an ordering (template) that is moving with respect to the external observer.

The scalar EM potential is any static (with respect to the external observer) ordering imposed upon the virtual photon flux of vacuum. Etc.

Note again that energy and potential have exactly the same definition. Potential is in fact trapped energy. Scalar EM potential is static EM energy (to the external observer) or trapped (collected) EM energy. In other words, if one takes off a differential of potential onto a fixed number of coulombs, one takes off a certain magnitude of trapped EM energy. In other words, one takes out a shovelful of coal from the coal car.

Importance of Separation of Charges

We Must Not Dispel the Separation of Charges In Our Source: The difference in our coal-fired train analogy and our electrical circuit is that, in the coal train, the coal in the coal car is not automatically and continually replenished. Also, the coal in the coal car has already been collected by the mass of the coal car, so it is not infinite.

In the electrical circuit, the potential gradient in the primary source is continually replenished, automatically, and it is infinite (though it has a finite energy density). The reason is simple. EM potential (in the normal sense) is actually a virtual photon flux exchange between the vacuum (the entire vacuum, all over the universe) and a charged particle or collection of charged particles.(24)

Thus the potential (gradient) is a powerful energy flux, pumped by the vacuum and the entire universe, that continues automatically, so long as we do not allow the collected charges in our bipolarity source to be dissipated.

In terms of a battery, we achieved separation of charges inside the battery by chemical action, and we paid for that initially. Once separated, the charges essentially stay separated (because of the chemistry) unless we foolishly do something to dissipate them, such as upsetting the chemistry, so they are no longer separated positive from negative.

So if we don't do anything to these separated charges, they continue to be driven by their fierce exchange of virtual photon flux with the vacuum/universe. If we then simply extract some of that flux exchange, without moving the charges, we are directly "gating" trapped EM energy from the vacuum/charged particle VPF exchange.(25)

The Potential Is Infinite And So Is Its Energy Content

You Can't Dip The Ocean Dry With a Spoon: Let's say that another way. The charged particles in our potential source are in a constant, seething, equilibrium exchange of trapped EM energy with the entire universe. That energy exchange is so enormous that, if we gate some of it out to collect on some other "temporarily frozen" charges and potentialize/activate them, the vacuum flux doesn't even miss it. It's like dipping a spoonful of water out of the restless ocean. The hole is instantly filled, and the water replenished. We can dip with that spoon as much as we wish, and the ocean will never run dry, but will simply continue to furnish us water, spoonful by spoonful.

The same is true in our electric circuits. We can have all the potential (trapped EM energy density) we wish, for free, from a single source, so long as we do not allow work to be done inside the source to close off our "gate" and kill our primary source.

The Twisted Concept of Voltage

Before We Develop Some Pseudo-Equations: In the equations we wish to develop, we have one problem, due to the lack of insight of conventional electrical physicists. That is, they have insisted upon "measuring" and expressing both the infinite potential (nondissipated) and a certain quantity of potential (dissipated) in volts.

So they say "a potential of so many volts." That's nonsense, and totally erroneous. Rigorously, a voltage is a drop or a dissipation of so much (a finite amount of) collected excess potential/energy. You "measure" the voltage in a voltmeter by impressing a potential gradient upon the electron gas in the circuitry, wherein you collect or get in your voltmeter so much [(joules/coulomb) x coulombs].

A tiny current (coulombs/second) from this internal collection then flows for a finite time through the resistance of the voltmeter. So you dissipate (joules/coulomb) \times (coulombs/second) \times (seconds), which gives a certain amount of energy dissipated as work in moving the needle of the voltmeter.

The voltmeter is calibrated so that it effectively indicates the collected energy per coulomb that was dissipated, and it calls that entity voltage. It involves a finite amount of energy that has already been dissipated as work, and it's a measure of the local energy density of the potential in terms of joules/coulomb. It is not a measure of the potential proper.

It's after the fact; the extracted (collected) potential gradient it actually refers to existed in the past, before the work (dissipation of the collected trapped energy) was done. To refer to the potential before its dissipation as "voltage" is precisely the same as confusing the future with the past. A "potential (difference) of so many volts" is actually a statement that "a potential difference of so much energy per coulomb" could be dissipated in a load, if it were connected to the load so that a finite amount of energy was collected, and this finite load-collection was allowed to dissipate as power (volts/coulomb \times coulomb/sec) for a finite time, yielding work. It's even worse, but it would take a textbook to straighten out this one error in EM theory.

So we'll leave it at that, and we'll adapt the notion of potential the way it is corrupted in electrical circuit theory. There it's used not really as energy, but rather as excess energy per coulomb of potentialized charge. I apologize for that difficulty, which is not of my own making, but I must use the conventional notion if we are to greatly clarify the pseudo equations.

The Equations of Free Energy

The Pseudo-Equations: Let us use the following subscripts and letter convention, and develop the nomenclature needed:

T = trapped

d = dissipated or dissipating

m = translated (moving)

K = energy

V = volts = potential drop (potential dissipated) = previously collected potential radiated away as heat in a load, doing work on the load in the process. Unfortunately we shall also have to speak of a potential gradient that is not being dissipated, so we shall have to speak of "trapped volts" which is erroneous, but complies with the common usage.

0 = electrostatic scalar potential.

Coul = coulombs

$i = \text{amperes} = \text{Dissipating potentialized coulombs per second flowing, so amps are something translating, always. Amps are excited coulombs, per second, that are dissipating their excitation. With superconductivity excluded, you only have amps when you have a potential drop across a load. So we will speak of amps as "dissipating," meaning that potentialized electrons are traveling through a load, dissipating their activation (gradients) in the load by radiating scattered photons (heat).}$

$n = \text{number of electrons in a coulomb} = 6.3 \times 10^{18} \text{electrons/coulomb}$

Here are the pseudo equations (superconductivity is excluded):

$\text{ampm} = \text{coul/sec} = n \text{ electronsm/sec} = n \text{ electronsd/sec} [1]$

$\text{delta}0 = VT$ (as conventionally referred to. It would be [2] volts if all of it were dissipated, but it is not yet dissipated, so it is sort of "trapped volts". Erroneous, but the common use. So we will speak (somewhat distastefully) of "trapped volts" and "dissipated volts."

$Vd \times \text{ampd} \times \text{sec} = \text{watts} \times \text{sec} = \text{power} \times \text{time} = \text{work} = Kd [3]$

$Vd \times \text{coul/sec} \times \text{sec} = (\text{work}) = Kd [4]$

In the switching, we switch KT to Kd so

$KT \rightarrow Kd [5]$

But $VT \times \text{coul}T = KT [6]$

Or $VT = [KT]/[\text{coul}T] = \text{trapped energy/trapped coulomb} [7]$

$KT = [VT] \times [\text{coul}T] = \text{amount of trapped energy, each cycle} [8]$

So that's what we were getting at. The amount of trapped energy you can transfer (in other words, how much coal you get in one shovelful) depends upon the number of trapped electrons you have in the trapped free electron gas in the collector, and the potential gradient you apply to those trapped coulombs to potentialize them.

Relaxation Time and Semiconductors

Relaxation Time: The time it takes for the free electrons in a conductor (or material) to reach the skin of the wire after potential is applied, is of course called the relaxation time.

During that time, the free electrons in the gas are "trapped" insofar as producing current (dissipation of the potential) is concerned. However, immediately after the relaxation time ends, current begins and dissipation of the trapped energy begins.

In copper, the relaxation time is incredibly rapid. It's about 1.5×10^{-19} sec. However, in quartz it is about 10 days! So as you can see, we need to get somewhere in between these two values, and so we will have to "mix" or "dope" materials.

We must get a sufficiently long relaxation time so that we can switch and collect comfortably in cycle one, then switch into cycle two for dispersion of the freely collected energy in the collector.

However, the relaxation time we get must also be short enough to allow quick discharge in the load, as soon as we switch the primary source away from the collector. Actually we need a degenerate semiconductor material instead of plain copper.

Degenerate Semiconductor Material: A semiconductor material is intermediate between a good conductor and an insulator. It's a nonlinear material, and doped. A degenerate semiconductor material is one which has all its conduction bands filled with electrons, and so it thinks it is a conductor. That is, a degenerate semiconductor is essentially a doped conductor, so to speak.

As you can see, we can increase the relaxation time in our "conductors" connected to the source by making them of degenerate semiconductor material. What we're talking about is "doping" the copper in the wire, and in the collector, so that we can have plenty of time to collect, and switch, and discharge, and switch, and collect, etc.

Now in a doped conductor (degenerate semiconductor), we can tailor the relaxation time by tailoring the doping. We must dope the copper before we make the wire. Why would we wish to do that? We want to overcome the single problem that so far has defeated almost all the "overunity" researchers and inventors.

WHEN YOU CONNECT TO A SOURCE, YOU CAN ONLY EXTRACT CURRENT-FREE POTENTIAL -- FREE "TRAPPED EM ENERGY" -- DURING THE ELECTRON RELAXATION TIME in the connecting conductors and succeeding circuit components. AFTER THAT, YOU'RE STEADILY EXTRACTING POWER, AND THE ENERGY EXTRACTED FROM THE SOURCE IS BEING PARTIALLY DISSIPATED IN THE RESISTANCE/LOADING OF THE CIRCUIT, AND PARTIALLY DISSIPATED IN THE INTERNAL RESISTANCE OF THE SOURCE. IN THE LATTER DISSIPATION, YOU'RE ALSO DISSIPATING YOUR SOURCE BY DOING WORK ON IT INTERNALLY TO KILL IT.

Good Copper Wire: Bane of Overunity Inventors: Many destitute inventors, tinkering and fiddling with overunity devices, finally get something (a circuit or device) that does yield more work out than they had to input.

At that point they usually conclude that it's simply the specific circuit configuration and its conventional functioning that produces the overunity work. However, usually as soon as this configuration is more carefully built with very good materials, boom! It isn't overunity anymore.

The inventors and their assistants then desperately bang and clang away, getting more frustrated as the years pass. The investors get mad, sue for fraud, or get in all sorts of squabbles. The scientists who tested it and found it wanting, pooh-pooh the whole thing as a scam and a fraud, or just a seriously mistaken inventor. Scratch one more "overunity" device.

Most of these inventors got their successful effect (and possibly erratically) when they were struggling with inferior, usually old, usually corroded materials. Actually, the more inferior, the better. The more contaminated/doped, the better!

The moment you wire up your circuit with good copper wire connected between the battery or primary source and any kind of load including the distributed circuitry loading itself, you can forget about overunity. You will lose it in the copper, after the first 1.5×10^{-19} second!

Think of a really good conductor such as copper as an essentially linear material. Linear means energy conservative. Overunity can only be done with a highly nonlinear effect. So your "conductors" have to be made of nonlinear materials. In fact, they have to be made of degenerate semiconductor material.

For the type of circuitry we are talking about, the copper has to be doped and then made into "doped copper" wiring. You also have to utilize the primary battery only to potentialize a collector (secondary battery/source), and then use this secondary battery source to conventionally power the load while also killing itself.

The Wiring And the Collector Must Be of Degenerate Semiconductor (DSC) Material.(26) A good materials scientist/engineer, together with a decent electrodynamicist, can readily design and tailor some doped copper wiring so that the material in the wiring is a degenerate semiconductor material, with a target (desired) relaxation time. That's what you should use to make the wiring to connect up your source to the collector with, and that type of material is also what you use in your collector.

You can use either a coil or a capacitor as the collector, but its "conductive" material has to be degenerate semiconductor material __ in short, it must be doped to have the proper relaxation time. From the collector to the load, however, obviously you want to use a good conductor material. Ordinary copper will do nicely there.

Once you do that, you're in business. When making the DSC material, simply tailor the relaxation time to something which is easily switched. For example, take one millisecond. With a relaxation time of that long, switching is easy. In fact, one could even use good mechanical switching. Or easily use inexpensive ordinary solid state switching, without having to go all the way to nanosecond switching.

Then in the collector you calculate the number of "trapped coulombs" you have. Take the "trapped voltage" (current-free potential's energy density per coulomb) you extract from the source during the electron relaxation time after the collector is connected. Multiply the number of trapped coulombs in the collector by the trapped voltage during collection, and you have the amount of energy in joules that you extract FOR FREE, without paying for it, from the source during every collection cycle.

Sources, Collectors, and Power

Tapping Vacuum Energy. You're getting the excess electrical energy directly from the vacuum, as we briefly pointed out above. The vacuum will freely replenish all the "trapped voltage" you extract from the primary source during the electron relaxation time. It won't replenish a single bit of "dissipated voltage" (power) you extract from the source.

Note that the same considerations apply in the collector. It's got to have a somewhat longer electron relaxation time. Its electrons stay "unrelaxed" during the collection cycle, and allow for some additional switching time to connect to the load.

The "trapped voltage" across the collector multiplied by the number of trapped coulombs in it, gives the number of joules of FREE EM ENERGY you extract and get into and onto the collector (the shovel). In other words, that's your "shovelful of coal."

You then throw the "shovelful" onto the fire/load — you simply disconnect the collector from the primary source and connect it across the external load. The collector (secondary battery) now powers the load and its own internal resistance, "killing" itself while furnishing the energy for powering the external load as well.

The Source Can Be Almost Anything: You can use as a source a simple elevated wire, to "tap" potential from the 200-300 volts/meter between earth and ionosphere. Here again, you need to utilize calibrated, doped wire.

Finally, you must adjust the repetition switching in accordance with the discharge time through the load. In other words, you have a serial process as follows:

- (1) extract trapped energy (potential) from the source onto the collector, delta t1.
- (2) Switch the collector off the source, onto the load, during time delta t2.
- (3) Wait while the collected energy in the collector discharges through the load, during time delta t3.

(4) Switch the collector back off the load and onto the potential source, during time Δt_4 . That completes one cycle.

The serial timing simply is $[\Delta t_1 + \Delta t_2 + \Delta t_3 + \Delta t_4]$.

If you balance all the doping and the materials design, and correlate the switching, you can get all the free energy you wish. Properly utilized, a single car battery can be used to power an electric automobile indefinitely. Or even to power a battleship.

In the real world, of course, you will inevitably have a tiny bit of loss as you go, because there's a finite (though high) resistance between the two poles of your battery. Handling that is a piece of cake. Simply run a separate little collection circuit to collect a little bit of trapped EM energy from the slowly leaking source, and ever so often feed the collected energy back into the battery as power, to "reseparate" the charges (charge the battery) and replace the small amount of the primary source's potential gradient that has been lost. The battery, load, and "trickle charger" then become a closed-circuit free-energy source that will last for years and years.

Limited Only By One's Imagination: Of course you can see many variants; this is just the "master key." You can have multiple collectors, collecting trapped energy simultaneously or in sequence off a single source, and pooling their collected energy to more powerfully power the load.

You can utilize a very high "voltage", such as in the Swiss electrostatic overunity device, to increase the energy collected per coulomb in each switching (in each shovelful) in accord with equation [8].

For a battery, you can set a separate little collector/load device to trickle-charge the battery, overcoming the small normal "leakage current" that does occur in batteries and in real circuits and devices. The opportunities are endless. You can put in a unit to take mostly only power-free energy from the "power line" feeding your business or home, reducing your utility bill by -- say -- 90%.

Or you can simply build a small home power unit to do the whole job, for only a few hundred dollars. This simple secret can be used to power the world, cheaply and cleanly, and to clean up the biosphere.

Conclusion

Well, there you have it. I've given you the benefit of what required most of my adult life to discover. The definitions advanced in this paper are rigorous. It took years of sweat and tears to come up with them. They're simple, but they will change your entire understanding of electromagnetics, power, and energy once you grasp them. Please read them, and ponder them, several times. One or two readings will not be sufficient to fully grasp what is said here.

Also, hopefully by this time the reader is beginning to experience the same emotions as I experienced when I finally discovered how simple it all really was. First one wants to laugh for about two hours at how truly ignorant we've all been. Then one wants to cry for about two hours for the same reason. This could all have been done a century ago, if we had ever really understood electromagnetics.

We've had this electromagnetics around for over 100 years — Maxwell's book was published in 1873. We got it wrong, starting right with Maxwell and his use of the material ether, which was almost universally assumed at the time.

Still, by using quaternions, Maxwell succeeded in packing a great deal more in the model than even he himself recognized. When the vector aspects interacted to form a zero resultant translationally, those active interactants were still in there and still fighting and interacting. The scalar component of the quaternion remained, and infolded those struggling vectors and functions of them inside itself.

In short, it captured the case where the electromagnetic energies are involved in translation actions which nullify each other translationally (electromagnetically). However, the energies are still in there in the continuing interactants inside the zero vector resultant. As such, they are trapped EM energy.

And it is the trapped EM energy inside a mass -- not the mass per se -- which is responsible for gravitation. In other words, Maxwell's theory already correctly captured the unification of the gravitational field and the electromagnetic field in 1873.

Then Heaviside et al forced Maxwell's theory into a vector framework, throwing out the scalar component, and discarding the unification of gravitation and electromagnetics along with it.

Serious errors were made and still exist in many of the fundamental definitions; in fact, many of them aren't definitions at all.

Nearly every engineer and physicist can readily calculate potentials — all, of course, on the "dissipation" side where the potentials are actually the amount of potential that was collected upon a collector and then dissipated. I could find hardly a single physicist who really knew what a scalar potential was prior to a finite amount being collected and dissipated as voltage. Yet 99% of them firmly believed they understood the potential.

So now you have the results of this researcher's long and arduous quest for the golden fleece. Please go forward with it, to make this a better and cleaner world for everyone.

Just remember that the control and use of energy is personal power. The control and use of absolute energy is the control and use of absolute

personal power. In the old adage, power corrupts and absolute power corrupts absolutely.

Please use it wisely.

Notes And References

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2. E. T. Whittaker, "On the partial differential equations of mathematical physics," *Mathematische Annalen*, Vol. 57, 1903, p. 333-355. Since the scalar potential actually consists totally of a set of hidden bidirectional EM waves, then scalar interferometry is possible, and not just an oxymoron as it would seem without considering the inner wave structure of the scalar potential. Two scalar potentials (each of which is a multi-biwave set) can interfere; it is just a special kind of multiple wave interferometry between their internal wave compositions. This is a major point of profound impact on physics. Whittaker in fact showed that all classical EM could be replaced by such scalar EM potential interferometry.

See E. T. Whittaker, "On an expression of the electromagnetic field due to electrons by means of two scalar potential functions," *Proceedings of the London Mathematical Society*, Series 2, Vol. 1, 1904, p. 367-372.

Further, scalar interferometry has been proven; today it is called the Aharonov-Bohm Effect. See Y. Aharonov and D. Bohm, "Significance of Electromagnetic Potentials in the Quantum Theory," *Physical Review*, Second Series, 115(3), Aug. 1, 1959, p. 458-491.

For confirmation and discussion, see Bertram Schwarzschild, "Currents in normal-metal rings exhibit Aharonov-Bohm Effect," *Physics Today*, 39(1),

Jan. 1986, p. 17-20. For an extensive discussion of the Aharonov-Bohm effect and an extensive list of references, see S. Olariu and I. Iovitzu Popescu, "The quantum effects of electromagnetic fluxes," *Reviews of Modern Physics*, 57(2), April 1985. Modern scientists have generally been unaware of the inner wave structure of the interfering potentials and have utilized only quantum mechanical theory for the interference. Consequently, they have been able to experimentally establish the AB effect for only a few thousand angstroms distance. With the Whittaker formulation, the AB effect becomes distant-independent, because the necessary potentials can be fabricated as laser-like beams, simply by assembling the proper Whittaker multibeam set.

Also, Ignatovich pointed out that the Schroedinger potential can also be decomposed into just such an internal bidirectional EM wave set. See V. K. Ignatovich, "The remarkable capabilities of recursive relations," *American Journal of Physics*, 57(10), Oct. 1989, p. 873-878.

3. See Richard W. Ziolkowski, "Exact Solutions of the Wave Equation With Complex Source Locations," *Journal of Mathematical Physics*, Vol. 26, 1985, p. 861; "Localized Transmission of Wave Energy," *Proc. SPIE*, Vol. 1061, Microwave and Particle Beam Sources and Directed Energy Concepts, 1989, p. 396-397; "Localized Transmission of Electromagnetic Energy," *Physical Review A*, Vol. 39, p. 2005; "Localized Wave Transmission Physics and Engineering," *Physical Review A*, 1992, (in Press); "Localized wave transmission physics and engineering," *Proc. SPIE Conference on Intense Microwave and Particle Beams II*, Los Angeles, CA, vol. 1407, Jan. 1991, p. 375-386.

See Richard W. Ziolkowski, Amr M. Shaarawi, and Ioannis M. Besieris, *Nuclear Physics B (Proc. Suppl.)*, Vol. 6, 1989, p. 255-258; R.W. Ziolkowski, and D.K. Lewis, D.K., "Verification of the Localized Wave Transmission Effect," *Journal of Applied Physics*, Vol. 68, 1990, p. 6083; Richard W. Ziolkowski, Ioannis M. Besieris, and Amr M. Shaarawi, "Localized Wave Representations of Acoustics and Electromagnetic Radiation," *Proceedings of the IEEE*, 79(10), Oct. 1991, p. 1371-1378; I.M. Besieris, A.M. Shaarawi, and R.W. Ziolkowski, "A bidirectional travelling plane wave representation of exact solutions of the scalar wave equation," *Journal of Mathematical Physics*, 30(6), 1989, p. 806; A.M. Shaarawi, I.M. Besieris, and R.W. Ziolkowski, "A novel approach to the synthesis of nondispersive wave packet solutions to the Klein-Gordon and the Dirac equations," *Journal of Mathematical Physics*, 31(10), 1990, p. 2511; "A nondispersive wave packet representation of photons and the wave-particle duality of light," UCRL-101694, Lawrence Livermore National Laboratory, Livermore, CA, 1989; "Diffraction of a classical wave packet in a two slit interference experiment," UCRL-100756, Lawrence Livermore National Laboratory,

Livermore, CA 1989; "Localized energy pulse trains launched from an open, semi-infinite, circular waveguide," *Journal of Applied Physics*, 65(2), 1989, p. 805; R.W. Ziolkowski, D.K. Lewis and B.D. Cook, "Experimental verification of the localized wave transmission effect," *Physical Review Letters*, 62(2), 1989, p. 147; R.W. Ziolkowski and D.K. Lewis, "Verification of the localized wave transmission effect," *Journal of Applied Physics*, 68(12), 1990, p. 6083; M.K. Tippet and R.W. Ziolkowski, "A bidirectional wave transformation of the cold plasma equations," *Journal of Mathematical Physics*, 32(2) 1991, p. 488; A.M. Vengsarkar, I.M. Besieris, A.M. Shaarawi, and R.W. Ziolkowski, "Localized energy pulses in optical fiber waveguides: Closed-form approximate solutions," *Journal of the Optical Society of America A*, 1991.

4. For a precise statement of the distortion correction theorem, see Amnon Yariv, *Optical Electronics*, 3rd Edn., Holt, Rinehart and Winston, New York, 1985, p. 500-501.

5. Both wave and antiwave co-exist in the vacuum simultaneously, forming a stress wave. The entity that is stressed is the rate of flow of time. In the common interaction with matter, the time-forward half of the stress wave normally interacts with the electron shells of the atom, giving electron translations forces. The time-reversed or anti-wave half interacts with the nucleus, giving the Newtonian 3rd law reaction (recoil) forces. The so-called "EM wave" in vacuum is a gravitational wave. It is a wave of oscillation of the rate of flow of time. It is rather like a sound wave in air, as Tesla pointed out, and it is a longitudinal wave, not a transverse "string" wave.

6. As pointed out by Nikola Tesla. Tesla was correct, and all the textbooks with their transverse "string" waves are in error. There are no strings in the vacuum!

7. E.g., see Clayton R. Paul and Syed A. Nasar, *Introduction to Electromagnetic Fields*, 2nd Edn., McGraw-Hill, New York, 1982, p. 113.

8. E.g., see Clayton R. Paul and Syed A. Nasar, *ibid.*, p. 100-101.

See also Raymond A. Serway, *Physics For Scientists And Engineers, With Modern Physics*, Saunders College Publishing, Philadelphia, PA, 3rd Edn., Updated Version, 1992, p. 752-755.

9. Sommerfield's theory of metallic conduction was based on Drude's concept that the outer valence electrons of a conductor, which do not form crystal bonds, are free to migrate through the crystalline lattice structure, and so to form an electron gas. At room temperature, by quantum mechanical considerations these free electrons are moving randomly, but at an average velocity on the order of 10⁶ meters per sec. E.g., see Martin A. Plonus, *Applied Electromagnetics*, McGraw Hill, New York, 1978, p. 54-58, 62-3, 376-7. If you wish to know just how much power exchange is driving

the collisions of the electron gas in a copper wire, here is an illustration. In one cubic centimeter of copper wire, the power exchange in and out of the electron gas is some 4 billion billion watts. That's the equivalent of 4 billion large electric power plants, each of 1,000 megawatt capacity. And one cubic centimeter of copper is a lump about the size of the end of your little finger.

10. E. g., see .Raymond A. Serway, *ibid.*, p. 743-744 for a discussion and calculation of the electron drift velocity in copper.

11. Richard P. Feynman, Robert B. Leighton, and Matthew Sands, *The Feynman Lectures on Physics*, Addison-Wesley, New York, Vol. 1, 1963, p. 2-4. In the classical EM theory launched by Maxwell and later modified by Heaviside et al, this problem did not exist for the original theoretical formulation. In that formulation by Maxwell, and continued by Heaviside, a material ether is assumed for the model. The Michelson-Morley experiments of 1887 destroyed the notion of the material ether, but the classical electromagnetics model has never been corrected to rectify its very serious foundations flaw in this respect.

12. Robert Bruce Lindsay and Henry Margenau, *Foundations of Physics*, Dover Publications, New York, 1963, p. 283-287. Note on p. 283 that a "field of force" at any point is actually defined only for the case when a unit mass is present at that point. In spite of this, most classical electrodynamicists continue to adhere to the notion that the EM field exists as such in the vacuum, but do admit that physically measurable quantities such as force somehow involve the product of charge and field.

E.g., see J.D. Jackson, *Classical Electrodynamics*, 2nd Edn., John Wiley & Sons, New York, 1975, p. 249. Note that holding such a concept is tantamount to holding on to the material ether, and assuming that the vacuum itself is "measurable" or "observable."

13. The formula $F = ma$ is simply an algorithm for calculating the magnitude of the force. It states that "the magnitude of the force is equal to the magnitude of mass that is accelerating, multiplied by the magnitude of the acceleration." No such "equals" formula is a definition; it is only a calculational algorithm.

14. This falsifies one of the assumptions in the common notion of the scalar potential; that its gradient in vacuum is a force field. Let us falsify another part of the conventional concept of the potential. Take the notion of forcibly pushing in "against the field" of a trapped charge, a unit charge from infinity. At any point you stop, the work n you have done on the unit charge is equal to the value of the potential, so it is said. Actually, you pushed in a one-coulomb collector, and have collected and dissipated as work n joules of energy on that one coulomb. In other words, the energy density of the potential there, if collected and dissipated on a collector, is n,

where n is joules per coulomb (NOT joules!). To prove it: Suppose we go out on 10,000 radials from that point, and push in from infinity 10,000 unit charges from infinity. Then the total work done "against the potential gradient ("field," in common language) is now 10,000 n . This makes no sense at all from the conventional view (which carefully refrains from multiple collectors!). It makes good sense from our view of the potential as having infinite energy but a finite energy density. In that case, the more collectors, the more energy collected, for dispersal as work.

15. For a discussion, see Y. Aharonov and D. Bohm, 1959.

16. Nikola Tesla, "The True Wireless," *Electrical Experimenter*, May 1919, p. 87.

17. The power in the load is always the time rate of dissipation of energy that has just been freely collected by the load for dissipation.

18. One can foresee a day in the not too distant future when any power company continuing to do such an unthinkable thing will have a class action suit brought against it by its customers!

19. T. E. Bearden, "Mechanism for Long-Term Cumulative Biological Effects of EM Fields and Radiation," March 1993 (in preparation).

20. Precisely analogous to a heat pump's operation - which as is well-known can readily be "over unity" in its efficiency. The maximum efficiency of the heat pump is about 8.22.

E.g., see David Halliday and Robert Resnick, *Fundamentals of Physics*, 3rd Edition Extended, John Wiley and Sons, New York, 1988, Volume 1, p. 510-519. Good heat pumps normally have about 4.0 efficiency.

21. External power in an electric circuit refers to the dissipation rate (in the circuit's external load) of the potential gradients on the activated/potentialized electrons. Internal power refers to the dissipation rate in the circuit's bipolarity source.

22. We call strong attention to T.W. Barrett, "Tesla's Nonlinear Oscillator-Shuttle-Circuit (OSC) Theory," *Annales de la Fondation Louis de Broglie*, 16(1), No. 1, 1991, p. 23-41. In this important paper, Barrett shows that a higher topology EM, such as quaternion EM, allows many things to be accomplished with circuitry that are not apparent to a conventional vector or tensor analysis of that circuitry. He also shows that Nikola Tesla's circuits accomplished this higher topological functioning.

23. It is easy to test this. Connect several different wires to a single source of potential gradient. With respect to ground, the end of each one of those wires has the same potential gradient as does the original source with respect to ground.

If you connect 10 wires to a single "100-volt" potential gradient source, you will have ten 100-volt potential gradients appear. You can use each of these ten potential gradients as a primary source. From each of these new primary sources, you can branch ten more, and now have a hundred potential gradient sources. You can treat each of these hundred new sources now as a primary source. To each one, you can add a switcher, collector, and external load, and drive all 100 loads. Or instead, you can put ten switcher/collector/external load circuits with each of the hundred new primary sources, and power all 1,000 external loads. Energy/potential is free from any source, so long as you do not demand power from the same source.

24. Per Whittaker and Ziolkowski, this VPF exchange -- from consideration of its wave aspects -- consists of a harmonic series of bidirectional waves.

25. We are easily permitted to have free energy and violate the "local energy conservation law for a closed system." This is because the two-cycle system is not closed, and so instead we must apply local energy conservation for an open system with a hidden source. In any given time interval, the energy taken (scattered) from the system as external work cannot exceed the sum of the unscattered trapped energy that was in the system initially and the unscattered energy that flowed into the system during that time interval.

26. You can actually do away with the separate collector, and utilize the doped copper DSC material itself as the collector. However, you will not be able to collect nearly so much energy in each collection cycle, for dissipating in the load in the subsequent work cycle.

SPACE PROPULSION

CAN EMPTY SPACE ITSELF PROVIDE A SOLUTION

BY HAROLD E PUTHOFF

The Launch of a mighty rocket is truly an awe-inspiring sight. As it strains against the twin forces of gravity and inertia, we can only marvel at the progress we have made in our attempt to throw off the shackles that bind mankind to Earth.

But contemplation of the sheer expenditure of energy in such a launch must also make us wonder whether we will ever colonize even the closest planet, let alone travel to the stars. Although various propositions to surmount the difficulties involved have been put forward, we cannot help but hope that the brute force solutions we apply today will one day be replaced by alternatives we can now only dream of.

The Potential of "Empty Space"

Surprisingly enough, there are hints that potential help may emerge quite literally out of the vacuum of so-called "empty space" itself, the very medium we wish to conquer. Quantum theory tells us that empty space is not truly empty, but rather is the seat of myriad energetic quantum processes that could have profound implications for future space travel. To understand these implications it will serve us to detour for a moment to review briefly the historical development of the scientific view of what constitutes empty space.

At the time of the Greek philosophers, Demoncritus argues that empty space was truly a void, otherwise there would not be room for atoms to move around. Aristotle, on the other hand, argues equally forcefully that what appeared to be empty space was in fact a plenum (a background filled with substance), for did not heat and light travel from place to place as if carried by some kind of medium?

The argument went back and forth through the centuries until finally codified by Maxwell's theory of the luminiferous ether, a plenum that carried electromagnetic waves, including light, much as water carries waves across a lake. Attempts to measure the properties of this ether, or to measure the Earth's velocity through the ether (as in the famous Michelson-Morley experiment), however, met with failure. With the rise of special relativity, which did not require reference to such an underlying substrate, Einstein in

1905 effectively banished the ether in favor of the concept that empty space constitutes a true void. Ten years later, however, Einstein's own development of the general theory of relativity, with its concept of curved space and distorted geometry, forced him to reverse his stand and opt for a richly endowed plenum, under the new label *spacetime metric*.

It was the advent of modern quantum theory, however, that established the quantum vacuum, so-called empty space, as a very active place, with particles arising and disappearing, a virtual plasma, and fields continuously fluctuating about their zero baseline values. Such processes are called zero-point fluctuations (ZPF) of the vacuum, reflecting the fact that such activity remains even at the zero point of temperature (absolute zero) after all thermal effects have frozen out.

Empty Space as an Energy Reservoir

What does all this have to do with space travel? At its most fundamental level, we now recognize that the quantum vacuum is an enormous reservoir of untapped energy, with energy densities conservatively estimated by Nobelist Feynman and other to be on the order of nuclear energy densities or greater. Therefore, the nuclear energy densities or greater. Therefore, the question is, can the ZPF energy be "mined" for practical use? If so, it would constitute a virtually ubiquitous energy supply, a veritable "Holy Grail" energy source for space propulsion.

As utopian as such a possibility may seem, researcher Robert Forward at Hughes Research Laboratories, Malibu, CA, demonstrated proof-of-principle in a paper published in *Physical Review B* in 1984, "Extracting Electrical Energy from the Vacuum by Cohesion of Charged Foliated Conductors." Forward's approach exploited a phenomenon called the *Casimir Effect*, an attractive quantum force between closely spaced metal plates, names for its discoverer, H.G.B. Casimir of Philips Laboratories in the Netherlands. The Casimir force derives from the partial shielding of the interior region of the plates from the background zero-point fluctuations (ZPF) of the vacuum electromagnetic field. This shielding results in the plates being pushed together by the unbalanced ZPF radiation pressures, with a consequent conversion of vacuum energy to some other form such as heat. Proof that such a process violates neither energy nor thermodynamic constraints can be found in a paper by D. Cole and myself published in *Physical Review E* in 1993, under the title "Extracting Energy and Heat from the Vacuum." Attempts to harness the Casimir Effect for vacuum energy conversion are ongoing in our laboratory and elsewhere, with formats ranging from pinch effects in plasmas to bubble collapse in turbulent fluids as in sonoluminescence.

Yet another example in which Nature herself may have taken advantage of energetic vacuum effects is discussed in a model published by ZPF researchers A. Rueda of California State University at Long Beach, B. Haisch of Lockheed, and D. Cole of IBM. In a paper published in the *Astrophysical Journal* in 1995, they propose that the vast reaches of outer space constitute an ideal environment for ZPF acceleration of nuclei and thus provide a mechanism for “powering up” cosmic rays. Details of the model would appear to account for other observed phenomena as well, such as the formation of cosmic voids. Of interest here is a proposal put forward in a report published by the U. S. Air Force (to be described later) to investigate the possibility of utilizing a “sub-cosmic ray” approach to accelerate protons in a cryogenically cooled, collision-free vacuum trap and thus extract energy from the vacuum fluctuations by this mechanism.

Origins of Gravity and Inertia

Let us now go deeper, however. ‘What of the fundamental forces of gravity and inertia we seek to overcome in space travel? We have phenomenological theories that describe their effects (Newton’s Laws and their relativistic generalizations, but what of their origins?

The first hint that these phenomena might themselves be traceable to roots in the underlying fluctuations of the vacuum came in a 1967 study published by the well-known Russian physicist Andrei Sakharov. Searching to derive Einstein’s phenomenological equations for general relativity from a more fundamental set of assumptions, Sakharov came to the conclusion that the entire panoply of general relativistic phenomena could be seen as induced effects brought about by changes in the quantum-fluctuation energy of the vacuum due to the presence of matter. In this view the attractive gravitational force is more akin to the induced Casimir force discussed above, than to the fundamental inverse square law force between charged particles with which it is often compared. Although speculative when first introduced by Sakharov, this hypothesis has led to a rich and ongoing literature (including a contribution of my own in a 1989 *Physical Review A* publication) on quantum-fluctuation-induced gravity, a literature that continues to yield deep insight into the role played by vacuum forces.

Given an apparent deep connection between gravity and the zero-point fluctuations of the vacuum, it was only a matter of time before a similar connection had to be made between these self-same vacuum fluctuations and inertia. Why? It is an empirical fact that the gravitational and inertial masses have the same value, even though the underlying phenomena are quite disparate. Why, for example, should a measure of the resistance of a body to being accelerated, even if far from any gravitational field, have the same value

that is associated with the gravitational attraction between bodies? Indeed, if one is determined by vacuum fluctuations, so must the other.

To get to the heart of inertia, let us consider a specific example. You are standing on a train in the station. As the train leaves the platform with a jerk, you could be thrown to the floor. What is this force that knocks you down, seemingly coming out of nowhere? This phenomena, which we conveniently label inertia and go on about our physics, is a subtle feature of the universe that has perplexed generations of physicists from Newton to Einstein. Since in this example the sudden disquieting imbalance results from acceleration "relative to the fixed stars," in its most provocative form one could say that it was the "stars" that delivered the punch. This key feature was emphasized by the Austrian philosopher of science Ernst Mach, and is now known as Mach's Principle. Nonetheless, the mechanism by which the stars might do this deed has eluded convincing explication-until now.

Addressing this issue in a paper entitled "Inertia as a Zero-Point Field Lorentz Force," published in *Physical Review A* in 1994, I and my colleagues Haisch and Rueda (mentioned earlier) were successful in tracing the problem of inertia and its connection to Mach's Principle to the ZPF properties of the vacuum. In a sentence, although a uniformly moving body does not experience a drag force from the (Lorentz-invariant) vacuum fluctuations, an *accelerated body* meets a resistance (force) proportional to the acceleration. By *accelerated* we mean, of course, accelerated relative to the fixed stars. It turns out that an argument can be made that the quantum fluctuations of distant matter structure the local vacuum-fluctuation frame of reference. Thus, in the example of the train the punch was delivered by the wall of vacuum fluctuations, acting as a proxy for the fixed stars, through which one attempted to accelerate.

Again, what does all this have to do with space travel? *There is experimental evidence that vacuum fluctuations can be altered by technological means. This leads to the corollary that, in principle, gravitational and inertial masses can also be altered.*

The evidence for the alteration of vacuum fluctuations is found in the research area called cavity quantum electrodynamics (QED). There, excited atoms are passed through Casimir-like cavities whose structure suppresses electromagnetic cavity modes at the transition frequency between the atom's excited and ground states. The result is that the so-called "spontaneous" emission time is lengthened considerably (for example, by factors of ten), simply because spontaneous emission is not so spontaneous after all, but rather is driven by vacuum fluctuations. Eliminate the modes and you eliminate the zero-point fluctuations of the modes, hence suppressing decay of the excited state. As stated in an April 1993 *Scientific American* review article on cavity QED, "An excited atom that would ordinarily emit a low-frequency photon

cannot do so, because there are no vacuum fluctuations to stimulate its emission....”

The Forward Report to the Air Force

Does anyone take seriously the concept that it might be possible to alter mass, with a view to easing the energy burden of future spaceships? In fact, the implication for space travel of our innovative ZPF-based inertia model has attracted the attention of the Advanced Concepts Office of the Propulsion Directorate of the Phillips Laboratory at Edwards Air Force Base. This office is charged with initiating research relevant to the development of 21st century space propulsion, and it is well understood that a fundamental understanding of inertia could well contribute to new concepts in this area. It was in this context that Robert Forward (the same Forward mentioned earlier!), a respected authority in the area of gravitation theory and measurement, accepted an assignment to review our concept and program. He recommended a broad, multi-pronged effort, involving laboratories from around the world, to investigate our inertia model experimentally.

After a one-year investigation Forward finished his study and submitted his report to the air force, who published it under the title *Mass Modification Experiment Definition Study*. The abstract reads in part:

“Many researchers see the vacuum as a central ingredient of 21st century physics. Some even believe the vacuum may be harnessed to provide a limitless supply of energy. This report summarizes an attempt to find an experiment that would test the Haisch, Rueda and Puthoff (HRP) conjecture that the mass and inertia of a body are induced effects brought about by changes in the quantum-fluctuation energy of the vacuum.... It was possible to find an experiment that might be able to prove or disprove that the inertial mass of a body can be altered by making changes in the vacuum surrounding the body,”

With regard to action items, Forward in fact recommends a ranked list of not one but *four* experiments to be carried out to address the ZPF-inertia concept and its broad implications, including investigation of the proposed subcosmic-ray energy device mentioned earlier.

Warp Drives and Wormholes

Since we are pushing the frontiers, we might as well address perhaps one of the most speculative, but nonetheless scientifically grounded, proposals of all: the Alcubierre Warp Drive. Taking on the challenge of determining whether Warp Drive *à la* Star Trek was a scientific possibility, general relativity theorist Miguel Alcubierre of the University of Wales set himself the task of determining whether faster-than-light travel was possible within the constraints of standard theory. Although this clearly could not be the case in the flat space of special

relativity, general relativity permits consideration of altered spacetime metrics where such a possibility is not *a priori* ruled out. Alcubierre's further self-imposed constraints on an acceptable solution included the requirements that no net time distortion should occur (breakfast on Earth, lunch on Alpha Centauri, and home for dinner with your wife and children, not your great-great-great grandchildren), and that the occupants of the spaceship were not to be flattened against the bulkhead by unconscionable accelerations.

A solution meeting all of the above requirements was found and published by Alcubierre in *Classical and Quantum Gravity* in 1994. The solution discovered by Alcubierre involved the creation of a local distortion of spacetime such that spacetime is expanded behind the spaceship, contracted ahead of it, and yields a hypersurfer-like motion faster than the speed of light as seen by observers outside the disturbed region. In essence, on the outgoing leg of its journey the spaceship is pushed away from Earth and pulled toward its distant destination by the engineered local expansion of spacetime itself. (For follow-up on the broader aspects of "metric engineering" concepts, one can refer to a paper published by myself in *Physics Essays* in 1996.) Interestingly enough, the engineering requirements rely on the generation of macroscopic, negative-energy-density, Casimir-like states in the quantum vacuum of the type discussed earlier. Unfortunately, meeting such requirements is presently beyond our technological reach.

Finally, of course, it has been known for some time that general relativity permits the possibility of *wormholes*, topological tunnels which in principle could connect distant parts of the universe, a cosmic subway so to speak. Publishing in the *American Journal of Physics* in 1988, theorists Morris and Thorne have outlined the requirements for traversable wormholes, and have found that, in principle, the possibility exists provided one has access to (yes, you guessed it) engineerable, Casimir-like, negative-energy-density quantum vacuum states.

"Magic"

Where does all this leave us? As we peer with longing into the heavens from the depth of our gravity well, hoping for some "magic" solution that will launch our spacefarers first to the planets and then to the stars, we are reminded of Arthur C. Clarke's phrase that highly advanced technology is essentially indistinguishable from magic. Fortunately, such magic appears to be waiting in the wings of our deepening understanding of the quantum universe in which we live, and it is only a matter of time before such magic will become the handmaiden of mankind's drive to explore the beckoning highways and byways of interstellar space.

Dr. Hal Putboff is Director of the Institute for Advanced Studies in Austin, TX. He has published papers on electron-beam devices, lasers and quantum zero-point-energy effects and has patents issued and pending in the laser, communications and energy fields.

THE SUBTLE PULL OF EMPTINESS

BY CHARLES SEIFE

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There's no such thing as a free lunch -- except in quantum mechanics. Classical physics -- and common sense -- dictates that the vacuum is devoid not only of matter but also of energy. But quantum mechanics often seems to depart from common sense. A paper in the current issue of *Physical Review Letters* describes the first successful measurement of the ultimate quantum free lunch: the Casimir force, a pressure exerted by empty space.

The measurement, by physicist Steven Lamoreaux of Los Alamos National Laboratory, confirms the strange picture of the vacuum conceived in the 1920s by pioneering quantum physicists Max Planck and Werner Heisenberg. Even at absolute zero, they asserted, the vacuum is seething with activity. This "zero-point energy" can be thought of as an infinite number of "virtual" photons that, like unobservable Cheshire cats, wink in and out of existence-but should have a measurable effect en masse. That's what Lamoreaux has now shown. "We're excited; it confirms a very basic prediction of quantum electro-dynamics," says Ed Hinds of the University of Sussex in the United Kingdom.

For decades after Planck and Heisenberg described the zero-point energy, physicists preferred to ignore it. It's infinite, and as a physicist, "infinity's not a very useful quantity, so we get rid of it," says Charles Sukenik of the University of Wisconsin.

But an early clue that these infinite fluctuations can't be ignored came in 1948, when researchers at the Philips Laboratory in the Netherlands were studying the van der Waals force--a weak attraction between neutral atoms. At long distances, the van der Waals force weakened unexpectedly. Philips scientists Hendrick Casimir and Dik Polder found that they could explain the weakening when they pictured the force as resulting from correlated zero-point fluctuations in the electric field, which would propagate from atom to atom at the finite speed of light. Because of the lag, the chance that the atoms would feel each other's fluctuations while they were still correlated would fall off at longer ranges. This weakening, called the Casimir-Polder effect, was first accurately measured in 1993, by Hinds, Sukenik, and their colleagues.

Casimir had also realized that the zero-point energy should reveal itself more directly, as a very weak attraction between two surfaces separated by a

tiny gap. Provided the gap was small enough to exclude some of the virtual photons, the crowd of photons outside the cavity would exert a minute pressure.

To measure it, Lamoreaux positioned two gold-coated quartz surfaces less than a milcrometer apart, one of them attached to a torsion pendulum while the other was fixed. The surfaces created a "box" that allowed only virtual photons of certain wavelengths to exist inside it. Outside the box, a full complement of virtual particles was merrily winking away. The infinite zero-point energy on the outside of the box outweighed the infinite (but smaller) zero-point energy inside, forcing the surfaces together.

By counteracting this subtle attraction with piezoelectric transducers, which exert a force when a voltage is applied to them, Lamoreaux was able to measure the force. The result: a value of less than 1 billionth of a newton, agreeing with theory to within 5%.

Hinds and others say the experiment should help physicists accept that the subatomic world is every bit as weird as quantum mechanics predicts. "We feel in our hearts that we really do understand how things work -- even something as peculiar as vacuum fluctuations," says Hinds. Adds Sussex physicist Malcolm Boshier, who was on Hinds's Casimir-Polder team: "This is one of those experiments that is going to wind up in all of the textbooks."

ETHER: WHAT IS IT?

BY AMARA GRAPS

The properties of light have perplexed scientists ever since humans were capable of giving it thought. Newton thought of light as showers of particles. Young and Fresnel gave evidence for light as waves. Maxwell concluded: "Light consists of electromagnetic waves," after combined electricity and magnetism in his electromagnetic wave theory. If Maxwell's statement is true, then what do the waves travel in, since mechanical waves have to propagate in some medium?

This paper is a brief investigation of that medium- called the ether. If light truly is a wave, then an ether is essential. The properties of the hypothesized ether are very unusual. One type of medium is required by Maxwell's electromagnetic equations. Yet another type of medium is required from the noninterference of the ether with motions of bodies in our universe.

Maxwell derived his electric and magnetic field equations from his technique of analogy where he likened magnetic lines of force to incompressible fluid flow. However the waves in his electromagnetic field are transverse, that is, in a sinusoidal up and down (or sideways) motion. Transverse waves, cannot travel through a body of liquid or gas. These types of waves can only be conducted through solids, in a gravitational field, or along the surfaces of water.

Therefore the ether cannot be a fluid because transverse waves cannot pass through a fluid. The ether has to be a solid. A solid medium carries a transverse wave in the following way. As the wave passes through the ether, that portion of the ether has to be distorted at right angles to the transverse light wave. Then the forces holding that portion of the solid have to snap the ether back. The rate at which the light wave travels through the medium depends on the size of the force that snaps back the distorted region. The greater the force, the greater the snap-back, the more rapid the progression of the wave. Since we know that light travels at over 186,000 mi/sec, the snap-back by the forces must be extremely rapid- in fact the force holding each portion of the ether in place was calculated to be considerably stronger than steel.

A second type of medium results from our experience of seeing bodies able to move freely throughout the universe. Because we know that the motions of the bodies in our universe are not interfered with in any detectable way- it seems reasonable to assume that ether is nothing more than an extremely rarefied gas.

So we have a combination of properties that is very hard to visualize. The ether must be an extremely tenuous gas and possess a rigidity greater than that of steel.

About a dozen experiments have tested the existence of an ether. The most famous is the Michelson- Morley (M-M) experiment. I will focus on that one. After I describe the experiment, I will state the contradictory results and how some scientists have resolved the contradictions.

Michelson and Morley's experiment was designed to measure the motion of the earth through the ether. We are fixed on the earth, so the ether should move relative to us. The velocity of light (c) traveling through this ether would change for angles that ranged from light was traveling in the same direction as the ether ($c+v$) to light traveling in the reverse direction of the ether ($c-v$). The key instrument in their experiment was an interferometer which allows one to see light interference fringes. The role of the interferometer was to detect whether a beam of light, split into paths at right angles to each other and then recombined, has a difference in velocities over the two paths. The interferometer was set with one path parallel to the motion of the earth in its orbit, and then rotated to put the other path parallel to the motion of the earth.

The detailed set- up for the M-M experiment follows. Light from a source L is split into two beams by a half silvered mirror (e.g. it's coated with enough silver to reflect half the light and allow the remaining half to be transmitted) at P . The beams are reflected at two mirrors $S1$ and $S2$ respectively and return through the half-silvered mirror to the telescope at the other end, where Michelson and Morley noted the number of interference fringes n . To calculate n they first calculated a time for the light to traverse the paths $PS1P$ and $PS2P$. Then they calculated the difference in optical path defined as $D=c(t_1-t_2)$. Michelson and Morley rotated the experimental set-up 90 degrees and repeated the calculations. They calculated a new optical path: D' . If ether exists then the interference fringes should shift by n fringes where n is defined by $(D' - D)/\lambda$, and λ is the wavelength of the light source.

The result of the experiment was that they found no shifts in the interference fringes. The accuracy of their result was 10 km/sec. E.g., although the earth's orbital speed is 30 km/sec and the light's speed of 300,000 km/sec, the velocity of the earth relative to any ether frame must be less than 10 km/sec.

The experimental result introduces a conflict. Light waves, whatever their form, could not be mechanical waves in a physical medium. And if they were not waves in a physical medium, how could they be said to be waves at all?

Two resolutions of the conflict exist. Either an ether exists, and the M-M experiment didn't measure it or an ether doesn't exist, and light is not a wave.

Some scientists say that the ether exists and that the M-M experiment didn't measure it. One such scientist is H. Aspden, who claims that the ether is attached to the earth- it is a "localized ether." Consequently the M-M experiment didn't measure the ether because it was only designed to measure the linear motion of the earth through space, not rotational motion of the earth through space.

Another scientist is E. W. Silvertooth, who claims that any laser interferometer experiment analogous to the M-M experiment would give a null result. His idea is that the frequencies of the interfering beams are themselves dependent upon velocity relative to a fixed frame. Therefore the frequency will adjust exactly to cancel any effect due to the motion through the light-reference frame, and a null result is an inevitable consequence.

Lorentz and FitzGerald had a related idea that they called the "contraction hypothesis." They postulated that, as a result of the motion of the stationary ether, all bodies are contracted by a factor in the direction of the ether. Therefore an arm of the M-M interferometer parallel to the motion of the ether would be shortened by this amount, and no fringe shift would be obtained when the instrument was rotated. (Later the contraction hypothesis was discarded because an effect of the hypothesis was that the velocity of the interferometer should change every twelve hours due to the earth's rotation, and the effect was never found.)

Other scientists say that an ether doesn't exist, but that a better explanation must exist for the appearance of light as waves in many situations (one example is double-slit experiments). D. Larson promotes the idea that light are particles that travel in a sinusoidal fashion. On this basis, he can easily explain why radiation can have wave-like properties, such as that of polarization, even though it consists of discrete particles. Scott Murray promotes the idea that light are particles that travel in rarefactions and compressions, i.e. concentrations of photons, like sound waves traveling in concentrations of air molecules.

The resolutions listed above are only a small number of the many that creative scientists have thought up to explain the properties of light and the null result of the MM experiment. This paper up to this point has been about whether ether exists with relation to light's properties. The question is also important with relation to absolute frames of reference in physics. An ether signifies a fixed frame of reference that scientists can use in their measurements of the universe. Einstein's Special Theory of Relativity says that no such frame of reference exists, i.e. all motion is relative. The finding of an ether would shatter that hypothesis. Therefore, it is doubly important to investigate the ether hypothesis and alternate light theories further. I am not in a position to state a conclusion on whether or not ether exists, but I think that we

should think seriously about what light is, and not laugh at what is typically presented as absurd.

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EVERYTHING FOR NOTHING

BY DR HAL PUTHOFF'S

Classical physics tells us that if we think of an atom as a miniature solar system with electronic planets orbiting a nuclear sun, then it should not exist. The circling electrons SHOULD RADIATE AWAY their energy like microscopic radio antennas and spiral into the nucleus. To resolve this problem, physicists had to introduce a set of mathematical rules, called quantum mechanics, to describe what happens. Quantum theory endows matter and energy with both wave and particle-like characteristics. It also restrains electrons to particular orbits, or energy levels, so they cannot radiate energy unless they jump from one orbit to another.

Measuring the spectral lines of atoms verifies that quantum theory is correct. Atoms appear to emit or absorb packets of light, or photons, with a wavelength that exactly coincides with the difference between its energy levels as predicted by quantum theory. As a result, the majority of physicists are content simply to use quantum rules that describe so accurately what happens in their experiments.

Nevertheless, when we repeat the question: "But why doesn't the electron radiate away its energy?", the answer is: "Well, in quantum theory it JUST DOESN'T". It is at this point that not only the layman but also some physicists begin to feel that someone is not playing fair. Indeed, much of modern physics is based on theories couched in a form that works but they do not answer the fundamental questions of what gravity is, why the Universe is the way it is, or how it got started anyway. Surprisingly, there may be answers to these seemingly unanswerable questions. Perhaps even more surprising, the answers seem to be emerging from empty space, the vacuum, the void.

In fact, according to quantum theory, the vacuum, the space between particles of matter as well as between the stars, is not empty, it is filled with vast amounts of fluctuating energy.

To understand this extraordinary idea, we will have to take a detour into the phenomenon of "fluctuations" with which quantum theory abounds. Fluctuations arise as one of the most fundamental concepts to come out of the mathematics of quantum theory. This is the uncertainty principle enunciated by Werner Heisenberg in 1927, which says that it is impossible to know everything about a system because of what would seem to be inherent fluctuations in the very fabric of nature itself. Indeed, quantum mechanics is a

statistical theory that deals with probabilities and it has some profound consequences for our understanding of reality. For instance, we cannot know the position and the momentum of an electron at the same time. If we know its momentum, or energy, accurately, then we can determine its position only probabilistically.

This "fuzziness" of positions described in terms of probability waves gives a measure of the size and shape over which an electronic orbit fluctuates in an atom. It also means that the energy of a particle or system is "fuzzy" and thus there is a slight probability of it changing, or fluctuating, to another value. In fact, a system can actually, by fluctuation, "tunnel" through an energy barrier because there is a small but finite probability of the system existing on the other side of the barrier. I shall discuss later a possible cause for such fluctuation phenomena.

The basic fuzziness of quantum theory means that there are fundamental phenomena which classical physics does not predict. For example, according to classical physics, any simple oscillator, such as a pendulum, when set in motion, comes to rest because of friction. But quantum theory predicts that such an oscillator would not completely come to rest, but instead, would continue to jiggle randomly about its resting point with a small amount of residual energy, the so-called zero-point energy.

The adjective zero-point denotes that such motion exists even at a temperature of absolute zero where no thermal agitation effects remain. Although we cannot observe the zero-point energy on, say, the pendulum of a grandfather clock because it is so minute, it is nonetheless real. In many physical systems this has important consequences. One example is the presence of a certain amount of "noise" in a microwave receiver that can NEVER be removed, no matter how perfect the technology.

This zero-point energy is the result of the unpredictable random fluctuations of the vacuum energy, as predicted by the uncertainty principle, which is zero in classical theory. In fact, these fluctuations can be intense enough TO CAUSE PARTICLES TO FORM from the vacuum SPONTANEOUSLY, provided they disappear again before violating the uncertainty principle. This temporary formation of "virtual" particles is somewhat akin to the spray that forms near a turbulent waterfall.

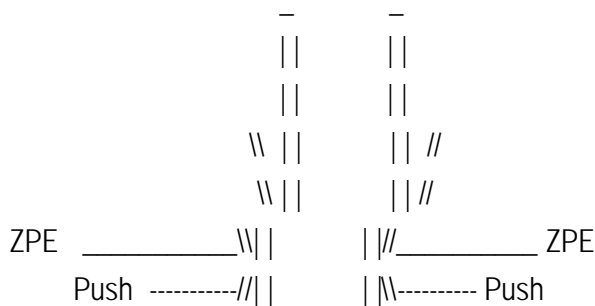
Of all the zero-point fluctuation phenomena, the zero-point fluctuations of electromagnetic energy are the most easy to detect. Electromagnetic waves have standing, or travelling modes, that are a bit like the various modes of waves going along a rope that is shaken. Each set of waves has its own characteristic set of nodes and crests. It turns out that even though the zero-point energy in any particular mode of an electromagnetic field is minute (equivalent to half a photon's worth), there

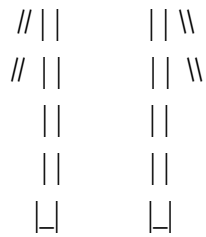
are nearly an infinite number of possible modes of propagation, that is frequencies and directions. The zero-point energy ADDED UP OVER ALL POSSIBLE MODES, therefore, is QUITE ENORMOUS. As hard as it is to believe, it is greater than the energy density in the atomic nucleus. And this in all of the so-called "empty" space around us.

Because the zero-point energy of the electromagnetic fields is so large, you might expect to see its effects easily, but this is not the case because its density is very uniform. Just as a vase standing in a true void is not likely to fall over spontaneously, so a vase bombarded UNIFORMLY on all sides by packets of zero-point energy would not do likewise because of the BALANCED CONDITIONS of the uniform bombardment. The only evidence of such a barrage of energy might be minute jiggling of the vase. Such a mechanism is thought to be involved in the quantum JIGGLE of zero-point motions.

There are situations, however, where the uniformity of the electromagnetic zero-point energy is slightly disturbed and this leads to effects you can ACTUALLY MEASURE. One situation is when the zero-point energy perturbs slightly the spectra of lines from transitions between quantum levels in atoms. This perturbation is known as the LAMB SHIFT, named after the American physicist, Willis Lamb. This work carried out in the late 1940's, using techniques developed for wartime radar, showed that the effect of zero-point fluctuations of the electromagnetic field was to jiggle the electrons slightly in their atomic orbits, leading to a shift in frequency of transitions of about 1000 MEGAHERTZ.

Another, also named after its discoverer, is the CASIMIR EFFECT -- which predicts that two metal plates close together ATTRACT EACH OTHER. Consider plates set at a certain distance apart. In the space between the plates, only those vacuum fluctuations for which a whole number of half-waves just spans the distance can exist, just like waves formed by shaking a rope tied at both ends. Outside the plates, the fluctuations can have many more values because there is more space. The number of modes outside the plates, all of which carry energy and momentum, is greater than those inside. This imbalance PUSHES THE PLATES TOGETHER.





Metal Plates

The Casimir Effect : An imbalance in the quantum fluctuations of empty space can PUSH two metal plates together

What does this have to do with our basic question of why the electron in a simple hydrogen atom does not radiate as it circles the protons in its lowest-energy orbit? I have considered this point by taking into account what other physicists have learned over the years about the effects of zero-point energy. I discovered that you can consider the electron as continually radiating away its energy as predicted by classical theory, but SIMULTANEOUSLY ABSORBING a COMPENSATING AMOUNT of energy from the ever-present sea of zero-point energy in which the atom is immersed. An equilibrium between these two processes leads to the correct values for the parameters that define the lowest energy, or ground-state orbit (see "Why atoms don't collapse," NEW SCIENTIST, July 1987). Thus there is a DYNAMIC EQUILIBRIUM in which the zero-point energy stabilizes the electron in a set ground-state orbit. It seems that the very stability of matter itself appears to depend on an underlying sea of electromagnetic zero-point energy.

Gravity as a Long-Range Casimir Force

As well as providing new insights into quantum theory, zero-point fluctuations also give us some insight into gravity. Einstein's general theory of relativity describes gravity well but we still do not know its fundamental nature very well. The theory is basically descriptive without revealing the underlying dynamics for that description. As a result, attempts to unify gravity with the other forces (electromagnetic, strong and weak nuclear forces) or to develop a quantum theory of gravity have foundered again and again on difficulties that can be traced back to a lack of understanding at a fundamental level. To rectify these difficulties, theorists have resorted to ever-increasing levels of mathematical sophistication and abstraction, as in the recent development of supergravity and superstring theories.

The well-known Soviet physicist Andrei Sakharov took a completely different tack to explain such difficulties. He suggested that gravity might not be a fundamental interaction at all, but rather a secondary or RESIDUAL

effect associated with other, non-gravitational fields. Gravity might be an effect brought about by changes in the zero-point energy of the vacuum, due to the presence of matter ("A key to understanding gravity", NEW SCIENTIST, April 1981). If correct, you could then consider gravity as a variation on the Casimir theme, in which the pressures of background zero-point energy were again responsible. Although Sakharov did not develop the concept much further, he did outline certain criteria such a theory would have to meet - for example, predicting the value of the gravitational constant G in terms of the parameters given by zero-point energy theory.

I have studied Sakharov's approach to gravity in detail with some positive results. A particle sitting in the sea of electromagnetic zero-point fluctuations develops a "jitter" motion, or ZITTERBEWEGUNG as German physicists have named it. When there are two or more particles, they are each influenced not only by the fluctuating background field, but also by the fields generated by the other particles, all similarly undergoing Zitterbewegung motion. The coupling between particles due to these fields produces the attractive gravitational force. Gravity can, therefore, be understood as a sort of LONG-RANGE Casimir force.

Because of its electromagnetic underpinning, gravitational theory in this form constitutes what is known as an "already-unified" theory. The main benefit of the new approach is that it helps us to understand characteristics of the way gravity works that were previously unexplained. These include why gravity is so weak; why positive but not negative mass exists; and the fact that gravity cannot be shielded because zero-point fluctuations pervade space and so cannot be shielded.

So, if we have an explanation for non-radiating atomic ground states and for gravity, do we know where the electromagnetic zero-point energy comes from in the first place? There are two schools of thought. One is that it is just simply a part of the boundary conditions of our Universe like, for example, the background radiation left over from the big bang. The other is that the zero-point energy is generated by quantum-fluctuation motion of the charged particles of the latter. I assumed that zero-point fields drive the motion throughout the Universe, in turn, generate the zero-point fields in the form of a self-regenerating feedback cycle, not unlike a cat chasing its own tail.

This self-consistent approach yielded the correct values for the zero-point field. Thus, the zero-point fields observed at any given point are due to random radiation arriving from particles throughout the Universe that are themselves undergoing zero-point motion ("Where does the zero-point energy come from?", NEW SCIENTIST, December 2, 1989). These self-regenerating zero-point fields also produce the familiar properties of quantum theory, such as fluctuation phenomena and the uncertainty principle, for example. This means that it might be possible to model many aspects of

quantum theory on the basis of self-consistent, random interactions between particles and the zero-point fluctuation fields they generate.

Although a knowledge of zero-point fields emerged from quantum physics as that subject matured, Timothy Boyer at City College in New York took a contrary view. In the late 1960's, he began asking what would happen if we took classical physics as it was and introduced a background of random, classical fluctuating zero-point fields. Such fields would presumably have originated in the initial random processes of the big bang and then by regeneration as I have just described. Could such an all-classical model reproduce quantum theory in its entirety, and might this possibility have been overlooked by the founders of quantum theory who were not aware of the existence of such a fluctuating background field?

Boyer began by tackling the problems that led to quantum theory being introduced in the first place, such as the blackbody radiation curve and the photoelectric effect. His upstart, neoclassical approach reproduced the known quantum results one by one. This approach is called STOCHASTIC ELECTRODYNAMICS (SED), in contrast to QUANTUM ELECTRODYNAMICS (QED). Indeed, Peter Milonni at the Los Alamos National Laboratory in the US noted in a review of the Boyer work that if physicists in 1900 had thought of taking this route, they would probably have been more comfortable with this classical approach than with Max Planck's hypothesis of the quantum. One can only speculate as to the direction that physics would have taken them.

The list of topics successfully analysed using the SED approach, which produce THE SAME RESULTS as when the QED approach is used, has now been extended to include the harmonic oscillator, Casimir and van der Waals forces and the thermal effects of acceleration through the vacuum. Out of this work emerged the reasons for such phenomena as the uncertainty principle, the fluctuating motion of particles, the existence of van der Waals forces even at zero temperature, and so forth, all show to be due to the influence of the unceasing activity of the random background fields.

There are also some notable gaps in the development of SED; for example, deriving Schrodinger's equation, as yet turns out to be an intractable problem. Several researchers are confident, however, that this obstacle can be overcome. Until theory as we have come to know it will be entirely replaced by a refurbished classical theory in the near future. But regardless of the final outcome, the successes to date of the SED approach, by its highlighting of the role of background zero-point fluctuations, means that when the final chapter is written on quantum theory, field fluctuations in empty space will be accorded an honoured position.

And now to the biggest question of all, where did the Universe come from? Or, in modern terminology, what started the big bang? Could quantum fluctuations of empty space have something to do with this as well? Edward Tyron of the City University of New York thought so in 1973 when he proposed that our Universe may have originated as a fluctuation of the vacuum on a large scale, as "simply one of those things which happen from time to time". This idea was later refined and updated within the context of inflationary cosmology by Alexander Vilenkin of Tufts University, who proposed that the universe is created by quantum tunnelling from literally nothing into the something we call the Universe. Although highly speculative, these models indicate that physicists find themselves turning again and again to the void and fluctuations therein for their answers.

Those with a practical bent of mind may be left with yet one more unanswered question. Can you find mundane applications for this emerging Rosetta Stone of physics? Will it be possible to extract electrical energy from the vacuum? Robert Forward at Hughes Research Laboratories in Malibu, California has considered this possibility. Could the engineer of the future specialise in "vacuum engineering" as the Nobel laureate Tsun-Dao Lee has put it? Could the energy crises be solved by harnessing the energies of the zero-point "sea"? After all, the basic form of zero-point energy is highly random and tends to cancel itself out, so if a way could be found to bring order out of chaos, then, because of the highly energetic nature of the vacuum fluctuations, relatively large effects could be produced.

Given our relative ignorance at this point, we must fall back on a quote given by the Soviet science historian Roman Poldolny when contemplating this issue. "It would be just as presumptuous to deny the feasibility of useful application as it would be irresponsible to guarantee such application." Only the future can reveal the ultimate use to which humans will put this remaining fire of the gods, the quantum fluctuations of empty space.

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ETHER AND THE THEORY OF RELATIVITY

BY ALBERT EINSTEIN

AN ADDRESS DELIVERED ON MAY 5TH, 1920, IN THE
UNIVERSITY OF LEYDEN

How does it come about that alongside of the idea of ponderable matter, which is derived by abstraction from everyday life, the physicists set the idea of the existence of another kind of matter, the ether? The explanation is probably to be sought in those phenomena which have given rise to the theory of action at a distance, and in the properties of light which have led to the undulatory theory. Let us devote a little while to the consideration of these two subjects.

Outside of physics we know nothing of action at a distance. When we try to connect cause and effect in the experiences which natural objects afford us, it seems at first as if there were no other mutual actions than those of immediate contact, e.g. the communication of motion by impact, push and pull, heating or inducing combustion by means of a flame, etc. It is true that even in everyday experience weight, which is in a sense action at a distance, plays a very important part. But since in daily experience the weight of bodies meets us as something constant, something not linked to any cause which is variable in time or place, we do not in everyday life speculate as to the cause of gravity, and therefore do not become conscious of its character as action at a distance. It was Newton's theory of gravitation that first assigned a cause for gravity by interpreting it as action at a distance, proceeding from masses. Newton's theory is probably the greatest stride ever made in the effort towards the causal nexus of natural phenomena. And yet this theory evoked a lively sense of discomfort among Newton's contemporaries, because it seemed to be in conflict with the principle springing from the rest of experience, that there can be reciprocal action only through contact, and not through immediate action at a distance.

It is only with reluctance that man's desire for knowledge endures a dualism of this kind. How was unity to be preserved in his comprehension of the forces of nature? Either by trying to look upon contact forces as being themselves distant forces which admittedly are observable only at a very small distance and this was the road which Newton's followers, who were entirely under the spell of his doctrine, mostly preferred to take; or by assuming that the Newtonian action at a distance is only apparently immediate action at a

distance, but in truth is conveyed by a medium permeating space, whether by movements or by elastic deformation of this medium. Thus the endeavour toward a unified view of the nature of forces leads to the hypothesis of an ether. This hypothesis, to be sure, did not at first bring with it any advance in the theory of gravitation or in physics generally, so that it became customary to treat Newton's law of force as an axiom not further reducible. But the ether hypothesis was bound always to play some part in physical science, even if at first only a latent part.

When in the first half of the nineteenth century the far-reaching similarity was revealed which subsists between the properties of light and those of elastic waves in ponderable bodies, the ether hypothesis found fresh support. It appeared beyond question that light must be interpreted as a vibratory process in an elastic, inert medium filling up universal space. It also seemed to be a necessary consequence of the fact that light is capable of polarisation that this medium, the ether, must be of the nature of a solid body, because transverse waves are not possible in a fluid, but only in a solid. Thus the physicists were bound to arrive at the theory of the "quasi-rigid" luminiferous ether, the parts of which can carry out no movements relatively to one another except the small movements of deformation which correspond to light-waves.

This theory also called the theory of the stationary luminiferous ether moreover found a strong support in an experiment which is also of fundamental importance in the special theory of relativity, the experiment of Fizeau, from which one was obliged to infer that the luminiferous ether does not take part in the movements of bodies. The phenomenon of aberration also favoured the theory of the quasi-rigid ether.

The development of the theory of electricity along the path opened up by Maxwell and Lorentz gave the development of our ideas concerning the ether quite a peculiar and unexpected turn. For Maxwell himself the ether indeed still had properties which were purely mechanical, although of a much more complicated kind than the mechanical properties of tangible solid bodies. But neither Maxwell nor his followers succeeded in elaborating a mechanical model for the ether which might furnish a satisfactory mechanical interpretation of Maxwell's laws of the electro-magnetic field. The laws were clear and simple, the mechanical interpretations clumsy and contradictory. Almost imperceptibly the theoretical physicists adapted themselves to a situation which, from the standpoint of their mechanical programme, was very depressing. They were particularly influenced by the electro-dynamical investigations of Heinrich Hertz. For whereas they previously had required of a conclusive theory that it should content itself with the fundamental concepts which belong exclusively to mechanics (e.g. densities, velocities, deformations, stresses) they gradually accustomed themselves to admitting electric and magnetic force as fundamental concepts side by side with those of

mechanics, without requiring a mechanical interpretation for them. Thus the purely mechanical view of nature was gradually abandoned. But this change led to a fundamental dualism which in the long-run was insupportable. A way of escape was now sought in the reverse direction, by reducing the principles of mechanics to those of electricity, and this especially as confidence in the strict validity of the equations of Newton's mechanics was shaken by the experiments with b-rays and rapid kathode rays.

This dualism still confronts us in unextenuated form in the theory of Hertz, where matter appears not only as the bearer of velocities, kinetic energy, and mechanical pressures, but also as the bearer of electromagnetic fields. Since such fields also occur in vacuo i.e. in free ether the ether also appears as bearer of electromagnetic fields. The ether appears indistinguishable in its functions from ordinary matter. Within matter it takes part in the motion of matter and in empty space it has everywhere a velocity; so that the ether has a definitely assigned velocity throughout the whole of space. There is no fundamental difference between Hertz's ether and ponderable matter (which in part subsists in the ether).

The Hertz theory suffered not only from the defect of ascribing to matter and ether, on the one hand mechanical states, and on the other hand electrical states, which do not stand in any conceivable relation to each other; it was also at variance with the result of Fizeau's important experiment on the velocity of the propagation of light in moving fluids, and with other established experimental results.

Such was the state of things when H. A. Lorentz entered upon the scene. He brought theory into harmony with experience by means of a wonderful simplification of theoretical principles. He achieved this, the most important advance in the theory of electricity since Maxwell, by taking from ether its mechanical, and from matter its electromagnetic qualities. As in empty space, so too in the interior of material bodies, the ether, and not matter viewed atomistically, was exclusively the seat of electromagnetic fields. According to Lorentz the elementary particles of matter alone are capable of carrying out movements; their electromagnetic activity is entirely confined to the carrying of electric charges. Thus Lorentz succeeded in reducing all electromagnetic happenings to Maxwell's equations for free space.

As to the mechanical nature of the Lorentzian ether, it may be said of it, in a somewhat playful spirit, that immobility is the only mechanical property of which it has not been deprived by H. A. Lorentz. It may be added that the whole change in the conception of the ether which the special theory of relativity brought about, consisted in taking away from the ether its last mechanical quality, namely, its immobility. How this is to be understood will forthwith be expounded.

The space-time theory and the kinematics of the special theory of relativity were modelled on the Maxwell-Lorentz theory of the electromagnetic field. This theory therefore satisfies the conditions of the special theory of relativity, but when viewed from the latter it acquires a novel aspect. For if K be a system of co-ordinates relatively to which the Lorentzian ether is at rest, the Maxwell-Lorentz equations are valid primarily with reference to K . But by the special theory of relativity the same equations without any change of meaning also hold in relation to any new system of co-ordinates K' which is moving in uniform translation relatively to K . Now comes the anxious question: Why must I in the theory distinguish the K system above all K' systems, which are physically equivalent to it in all respects, by assuming that the ether is at rest relatively to the K system? For the theoretician such an asymmetry in the theoretical structure, with no corresponding asymmetry in the system of experience, is intolerable. If we assume the ether to be at rest relatively to K , but in motion relatively to K' , the physical equivalence of K and K' seems to me from the logical standpoint, not indeed downright incorrect, but nevertheless unacceptable.

The next position which it was possible to take up in face of this state of things appeared to be the following. The ether does not exist at all. The electromagnetic fields are not states of a medium, and are not bound down to any bearer, but they are independent realities which are not reducible to anything else, exactly like the atoms of ponderable matter. This conception suggests itself the more readily as, according to Lorentz's theory, electromagnetic radiation, like ponderable matter, brings impulse and energy with it, and as, according to the special theory of relativity, both matter and radiation are but special forms of distributed energy, ponderable mass losing its isolation and appearing as a special form of energy.

More careful reflection teaches us, however, that the special theory of relativity does not compel us to deny ether. We may assume the existence of an ether,; only we must give up ascribing a definite state of motion to it, i.e. we must by abstraction take from it the last mechanical characteristic which Lorentz had still left it. We shall see later that this point of view, the conceivability of which shall at once endeavour to make more intelligible by a somewhat halting comparison, is justified by the results of the general theory of relativity.

Think of waves on the surface of water. Here we can describe two entirely different things. Either we may observe how the undulatory surface forming the boundary between water and air alters in the course of time; or else with the help of small floats, for instance we can observe how the position of the separate particles of water alters in the course of time. If the existence of such floats for tracking the motion of the particles of a fluid were a fundamental impossibility in physics if, in fact, nothing else whatever were observable than the shape of the space occupied by the water as it varies in time, we should

have no ground for the assumption that water consists of immovable particles. But all the same we could characterize it as a medium.

We have something like this in the electromagnetic field. For we may picture the field to ourselves as consisting of lines of force. If we wish to interpret these lines of force to ourselves as something immaterial in the ordinary sense, we are tempted to interpret the dynamic processes as motions of these lines of force, such that each separate line of force is tracked through the course of time. It is well known, however, that this way of regarding the electromagnetic field leads to contradictions.

Generalizing we must say this: There may be supposed to be extended physical objects to which the idea of motion cannot be applied. They may not be thought of as consisting of particles which allow themselves to be separately tracked through time. In Minkowski's idiom this is expressed as follows: Not every extended conformation in the four-dimensional world can be regarded as composed of worldthreads. The special theory of relativity forbids us to assume the ether to consist of particles observable through time, but the hypothesis of ether in itself is in conflict with the special theory of relativity. Only we must be on our guard against ascribing a state of motion to the ether.

Certainly, from the standpoint of the special theory of relativity, the ether hypothesis appears at first to be an empty hypothesis. In the equations of the electromagnetic field there occur, in addition to the densities of the electric charge, only the intensities of the field. The career of electromagnetic processes in vacuum appears to be completely determined by these equations, uninfluenced by other physical quantities. The electromagnetic fields appear as ultimate, irreducible realities, and at first it seems superfluous to postulate a homogeneous, isotropic ether-medium, and to envisage electromagnetic fields as states of this medium.

But on the other hand there is a weighty argument to be adduced in favour of the ether hypothesis. To deny the ether is ultimately to assume that empty space has no physical qualities whatever. The fundamental facts of mechanics do not harmonize with this view. For the mechanical behaviour of a corporeal system hovering freely in empty space depends not only on relative positions (distances) and relative velocities, but also on its state of rotation, which physically may be taken as a characteristic not appertaining to the system in itself. In order to be able to look upon the rotation of the system, at least formally, as something real, Newton objectivises space. Since he classes his absolute space together with real things, for him rotation relative to an absolute space is also something real. Newton might no less well have called his absolute space "Ether"; what is essential is merely that besides observable objects, another thing, which is not perceptible, must be looked upon as real, to enable acceleration or rotation to be looked upon as something real.

It is true that Mach tried to avoid having to accept as real something which is not observable by endeavouring to substitute in mechanics a mean acceleration with reference to the totality of the masses in the universe in place of an acceleration with reference to absolute space. But inertial resistance opposed to relative acceleration of distant masses presupposes action at a distance; and as the modern physicist does not believe that he may accept this action at a distance, he comes back once more, if he follows Mach, to the ether, which has to serve as medium for the effects of inertia. But this conception of the ether to which we are led by Mach's way of thinking differs essentially from the ether as conceived by Newton, by Fresnel, and by Lorentz. Mach's ether not only conditions the behaviour of inert masses, but is also conditioned in its state by them.

Mach's idea finds its full development in the ether of the general theory of relativity. According to this theory the metrical qualities of the continuum of space-time differ in the environment of different points of space-time, and are partly conditioned by the matter existing outside of the territory under consideration. This space-time variability of the reciprocal relations of the standards of space and time, or, perhaps, the recognition of the fact that "empty space" in its physical relation is neither homogeneous nor isotropic, compelling us to describe its state by ten functions (the gravitation potentials g), has, I think, finally disposed of the view that space is physically empty. But therewith the conception of the ether has again acquired an intelligible content, although this content differs widely from that of the ether of the mechanical undulatory theory of light. The ether of the general theory of relativity is a medium which is itself devoid of all mechanical and kinematical qualities, but helps to determine mechanical (and electromagnetic) events.

What is fundamentally new in the ether of the general theory of relativity as opposed to the ether of Lorentz consists in this, that the state of the former is at every place determined by connections with the matter and the state of the ether in neighbouring places, which are amenable to law in the form of differential equations; whereas the state of the Lorentzian ether in the absence of electromagnetic fields is conditioned by nothing outside itself, and is everywhere the same. The ether of the general theory of relativity is transmuted conceptually into the ether of Lorentz if we substitute constants for the functions of space which describe the former, disregarding the causes which condition its state. Thus we may also say, I think, that the ether of the general theory of relativity is the outcome of the Lorentzian ether, through relativation.

As to the part which the new ether is to play in the physics of the future we are not yet clear. We know that it determines the metrical relations in the space-time continuum, e.g. the configurative possibilities of solid bodies as well as the gravitational fields; but we do not know whether it has an essential share in the structure of the electrical elementary particles constituting matter.

Nor do we know whether it is only in the proximity of ponderable masses that its structure differs essentially from that of the Lorentzian ether; whether the geometry of spaces of cosmic extent is approximately Euclidean. But we can assert by reason of the relativistic equations of gravitation that there must be a departure from Euclidean relations, with spaces of cosmic order of magnitude, if there exists a positive mean density, no matter how small, of the matter in the universe. In this case the universe must of necessity be spatially unbounded and of finite magnitude, its magnitude being determined by the value of that mean density.

If we consider the gravitational field and the electromagnetic field from the standpoint of the ether hypothesis, we find a remarkable difference between the two. There can be no space nor any part of space without gravitational potentials; for these confer upon space its metrical qualities, without which it cannot be imagined at all. The existence of the gravitational field is inseparably bound up with the existence of space. On the other hand a part of space may very well be imagined without an electromagnetic field; thus in contrast with the gravitational field, the electromagnetic field seems to be only secondarily linked to the ether, the formal nature of the electromagnetic field being as yet in no way determined by that of gravitational ether. From the present state of theory it looks as if the electromagnetic field, as opposed to the gravitational field, rests upon an entirely new formal motif, as though nature might just as well have endowed the gravitational ether with fields of quite another type, for example, with fields of a scalar potential, instead of fields of the electromagnetic type.

Since according to our present conceptions the elementary particles of matter are also, in their essence, nothing else than condensations of the electromagnetic field, our present view of the universe presents two realities which are completely separated from each other conceptually, although connected causally, namely, gravitational ether and electromagnetic field, or as they might also be called space and matter.

Of course it would be a great advance if we could succeed in comprehending the gravitational field and the electromagnetic field together as one unified conformation. Then for the first time the epoch of theoretical physics founded by Faraday and Maxwell would reach a satisfactory conclusion. The contrast between ether and matter would fade away, and, through the general theory of relativity, the whole of physics would become a complete system of thought, like geometry, kinematics, and the theory of gravitation. An exceedingly ingenious attempt in this direction has been made by the mathematician H. Weyl; but I do not believe that his theory will hold its ground in relation to reality. Further, in contemplating the immediate future of theoretical physics we ought not unconditionally to reject the possibility that the

facts comprised in the quantum theory may set bounds to the field theory beyond which it cannot pass.

Recapitulating, we may say that according to the general theory of relativity space is endowed with physical qualities; in this sense, therefore, there exists an ether. According to the general theory of relativity space without ether is unthinkable; for in such space there not only would be no propagation of light, but also no possibility of existence for standards of space and time (measuring-rods and clocks), nor therefore any space-time intervals in the physical sense. But this ether may not be thought of as endowed with the quality characteristic of ponderable media, as consisting of parts which may be tracked through time. The idea of motion may not be applied to it.

AETHER, RELATIVITY AND SUPERFLUIDITY

BY BARRY C. MINGST

Abstract

A review of the basics of special and general relativity. The basis of both special relativity and general relativity is superfluid equations -- Maxwell's equations for special relativity and generalized superfluid equations for general relativity. Demonstration that a superfluid aether results in both special and general relativity as special cases. Resolution of the Feynman arguments against an aether as a gravitational source. Discussion of the Thirring-Lenz experiment tending to confirm physical aether medium versus "mathematical" or "continuum" cause of gravity.

Introduction

"According to the general theory of relativity space is endowed with physical qualities; in this sense, therefore, there exists an aether. According to the general theory of relativity space without aether is unthinkable."

A. Einstein, Sidelights on Relativity, 1922, page 23.

This paper examines one possible physically causative agent for gravitation of matter bodies. This causative agent is a superfluid aether. This aether is not matter, but matter is affected by the aether. Superfluidity is the basis for Maxwell's equations, special relativity, and general relativity.

The concept of the aether arose from the study of the behavior of wave action and light. Even before the kinetic theory of gases provided microscopic concepts, the study of the sensible world allowed a fairly consistent view of wave action. Light was clearly identified in the wave category of phenomena. The debate as to what the ultimate underlying nature of light was (wave or particulate) spanned several centuries of theory and experiment. Not until the twentieth century was it ever contended that "waves" of light did not have an underlying physical medium.

The main objection to fluid aether theories came from light's propagation as transverse waves. Up to the time of the general abandonment of deterministic (classical) physics at the microscopic level (with the rise of quantum physics in the 1920's) no "reasonable" way to explain this behavior of light was generally accepted. "The" aether theory being tested by the famous Michaelson-Morely experiment was the "solid" aether theory that was in

ascendence at the time. This theory assumed that the aether was physically separate from matter -- that is, they were not related.

The demise of the concept of the aether resulted from the tumultuous evolution of the physical concepts of the early twentieth century (quantum theory and general relativity). Quantum mechanicians developed the concepts of "probability density" and non-causality. General relativists picked up on the shorthand of space-time developed by Minkowski in 1908 for special relativity and expanded it to a mathematical "space-time continuum." Although most specifically denied a physical medium, Einstein clearly realized that both special and general relativity were based on fluid dynamical models {Handbook of Physics, Condon and Odishaw, Page 2-50, Section 29}.

The Derivation of Maxwell's Equations

One of the most successful theoretical works in physics is Maxwell's theory of electricity and magnetism. Maxwell's equations united and mathematically quantified the interaction of electrical and magnetic effects. In deriving these equations, Maxwell made certain assumptions about the nature of the medium that carried electricity, magnetism, and light. The primary assumption used by Maxwell was that the underlying medium could be described using the perfect fluid vortex theory developed by Hemholtz.

"The consideration of the action of magnetism on polarized light leads, as we have seen, to the conclusion that in a medium under the action of magnetic force is something belonging to the same mathematical class as an angular velocity, whose axis is in the direction of the magnetic force, forms a part of the phenomenon.

"This angular velocity cannot be that of any portion of the medium of sensible dimensions rotating as a whole. We must therefore conceive the rotation to be that of very small portions of the medium, each rotating on its own axis. This is the hypothesis of molecular vortices.

"The motion of these vortices, though, as we have shewn ..., does not sensibly affect the visible motions of large bodies, may be such as to affect that vibratory motion on which the propagation of light, according to the undulatory theory, depends. The displacements of the medium, during the propagation of light, will produce a disturbance of the vortices, and the vortices when so disturbed may react on the medium so as to affect the mode of propagation of the ray."...

"... We shall therefore assume that the variation of vortices caused by the displacement of the medium is subject to the same conditions which Hemholtz, in his great memoir on Vortex-motion, has shewn to regulate the variation of the vortices of a perfect fluid."

J. Maxwell, A Treatise on Electricity and Magnetism, 1873, sections 822 and 823.

There have been attempts in the past to "expand" Maxwell's equations in the name of symmetry. One of these was the concept of magnetic monopoles. It was determined that magnetic monopoles could be inserted into Maxwell's equations and the equations would remain self-consistent and usable. The hunt for magnetic monopoles in the 1970's ended without any confirmed monopoles. Another attempt was the expansion of Maxwell's equations to include positive and negative charges as "carriers" of the weak nuclear force. This is what is now known as the "electroweak" force. This expansion of Maxwell's equations is also self-consistent and usable. In this case particles of mass roughly in the range expected have been found.

What is missing from these expansions is any physical concept that would give rise to these expansions. It must be stressed that Maxwell derived his equations. He did not just write them down and then note that they happened to work. The derivation was the direct result of the physical postulates (superfluid aether and vortices) he made in his derivation. Magnetic monopoles and "weak" nuclear theory do not arise from Maxwell's equations. There is therefore no physical basis for expecting these equations to work.

The Derivation of Special Relativity

The special theory of relativity was derived from Maxwell's Equations. The Special Theory was a leap of quantification based on an apparent anomaly. Maxwell's equations imply that the measured speed of light (in a vacuum) is constant for any observer -- regardless of how that observer was moving relative to the source of light.

In developing Special Relativity, Einstein postulated the universality of the speed of light and applied the mathematical consequences to see where they would lead. The primary result of the special theory of relativity was the equivalence of matter and energy ($E=mc^2$). The Lorentz-Fitzgerald relations had been developed earlier from standard aether wave theories (which is why they are called Lorentz-Fitzgerald equations instead of Einstein equations). Special Relativity is therefore based on the superfluid derivations of Maxwell and Hemholtz.

Minkowski Space-Time

The concept of "space-time" was first developed by Minkowski in 1908 for use with the Special Theory of Relativity. In this first incarnation, Minkowski pointed out that the mathematical equations may be written in a shorthand form by regarding time and the three physical coordinates as four coordinates in a four-dimensional space, called "space-time."

In an inertial, cartesian reference frame a pulse of light emitted at time $t=t_0$ and location $x = x_0$, $y = y_0$, and $z = z_0$ will be noted at a point x , y , z , t given by the equation {eq 4.2 An Introduction to Tensor Calculus, Relativity and Cosmology, D Lawden, 1975, Wiley and Sons}:

This equation describes an expanding spherical shell for the light pulse. A shorthand version of this equation was developed by Minkowski by the use of the mathematical device of setting:

$$x = x_1, y = x_2, z = x_3, \text{ and } ict = x_4; \text{ where } i = \text{SqrRoot}(-1)$$

The standard Minkowski space-time is given as {eq. 4.5, An Introduction to Tensor Calculus, Relativity and Cosmology, D Lawden, 1975, Wiley and Sons}:

General Relativity

Einstein's "field" equations may be written in the tensor form:

In this form, $G_{\alpha\beta}$ is the "Einstein Tensor", Λ is the "cosmological constant" (usually set to zero), g is the "metric" tensor, k is a constant set to 8π , and $T_{\alpha\beta}$ is the "stress-energy tensor." This form is actually shorthand notation for ten coupled differential equations {Equation 8.7, A first course in general relativity, Schutz, Cambridge University Press, 1990}. The value of 8π is obtained by demanding that Einstein's equations predict the correct behavior of planets in the solar system -- the Newtonian Limit (ibid, p199).

The claim is currently made that the mathematics of General Relativity requires the curvature of space. The question "How?" is answered with "It just does." The question of why the object travels the shortest path in curved space is also not addressed. General Relativity can give no answer because these are the basic postulates of the theory.

The differences in the concepts between General Relativity and Newtonian gravity are:

Newtonian: Mass (somehow) causes a gravitational force which causes true acceleration.

Einsteinian: Mass (somehow) causes a warping of space which results in apparent acceleration.

But the description of causation as a curvature of space is not sufficient to encompass what else General Relativity includes. If spacial curvature were all there were to General Relativity, there would be no difference in calculations between General Relativity and Newtonian gravity. General Relativity also imposes superfluid equations onto gravitational relationships. The imposition of superfluid equations has a very significant effect: the speed of propagation of gravity is thereby made finite. The finite transmission speed (and related

superfluid properties) is the significant difference between Newtonian gravity and General Relativity.

General Relativity is a relativistic theory of gravity. The first postulate of General Relativity is that the source of the gravitational field is the stress-energy tensor of a perfect fluid, T {sections 4.6 & 4.7, A first course in general relativity, Schutz}. This "stress-energy tensor" contains four non-zero components. These four components are the density of the perfect fluid and the pressure of the perfect fluid in each of the three physical axes. A perfect fluid in general relativity is defined as a fluid that has no viscosity and no heat conduction. It is a generalization of the "ideal gas" of ordinary thermodynamics.

Newtonian gravity is regarded as the result of a force. General Relativity distinguishes gravity from all other forces because "all bodies given the same initial velocity follow the same trajectory in a gravitational field, regardless of their internal composition" {ibid, p121}. Specifically, attempting to define a primal reference frame is considered "vacuous, since no free particle could possibly be a physical 'marker' for it" {ibid, p122}. This second postulate became the Equivalence Principle: Uniform gravitational fields are equivalent to frames that accelerate uniformly relative to inertial frames.

Although it is often stated that General Relativity shows that mass curves space, what GR actually states is that a curved spacetime represents the effects of gravity. The distinction is critical. All GR really requires is that free particles (and photons) act as if space were curved in some manner. All this means is that their trajectories curve in the presence of a massive object {ibid, p125}.

The same argument could be made for Coriolis forces. If we examine the coriolis forces that affect trajectories of moving objects over the surface of a rotating planet, we could reach the same results by postulating that Latitude "curves" space. The results of our calculations would be identical to those based on the physical cause. But we would not gain any knowledge of the cause, because we would not be looking for one.

In the direct application of its basic postulate, General Relativity suffers from the same basic weakness as the Newtonian quantification of gravity. No basis is given in General Relativity for how mass "curves" space, why masses follow the "shortest" path through curved space, or why the principle of equivalence exists. This is "action at a distance" reformulated. Einstein himself noted this weakness in that matter had to be added in to the equations "by hand" {The Reluctant Father of Black Holes, Scientific American, June 1996, p83}.

Thirring Lenz Experiment

General Relativity has some weaknesses in explaining accelerations seen in the vicinity of massive, rapidly spinning objects. In this situation, the Einsteinian/Newtonian quantification predicts no effects on first principles. But the Einsteinian formula solutions "require" a non-zero tangential velocity to be imparted by a spinning mass.

First principles of a space-time continuum cannot explain accelerations in the vicinity of rapidly rotating massive objects because the "warp" of space-time does not change with the rotation of the object. It has been explained that "inertial dragging" takes place. The explanation of inertial dragging (reference frame dragging) is a description without identification of a cause that can be traced to the base theory {pp 6 & 18-20, Rotating Fields in General Relativity, J. Islam, 1985}. According to this reference "(t)he precise connection in all its details has not yet been worked out."

But such a "drag" implies that there is a friction in the motion of mass with respect to the space-time continuum itself. Friction due to motion with respect to the continuum requires that the continuum be a fixed, primal reference frame -- which must be denied due to the basic assumption of relativity, that there can be no primal reference frame. General relativistic formulations show the requirement of tangential motion when the assumption is made that the continuum is a superfluid.

Resolution of Some Arguments Against

Aether Cause of Gravity

LeSage first discussed the possible "shadowing" of "ultra-mundane particles" as a cause of gravity in 1784. This approach has been abandoned several times by different people. According to Feynman, LeSage-type theories fail as follows:

"This particular idea has the following trouble: the earth, in moving around the sun, would impinge on more particles which are coming from its forward side than from its hind side Therefore there would be more impulse given the earth from the front, and the earth would feel a resistance to motion and would be slowing up in its orbit. One can calculate how long it would take for the earth to stop as a result of this resistance, and it would not take long enough for the earth to still be in its orbit, so this mechanism does not work. No machinery has ever been invented that 'explains' gravity without also predicting some other phenomenon that does not exist."

R. Feynman, Lectures on Physics, 1963, volume 1, chapter 7, pp 9-10

Performing a calculation of the type above leads to a "drag" on the order of 10-13 m/sec² for the earth in orbit {Dr. Steve Carlip, private communication to Paul Stowe}. A continuous acceleration on this order would stop the earth in around a million years.

But there is an unstated assumption in Feynman's argument that the "aether particles" are not circulating with the Earth's orbital motion. This is an excellent first assumption, but is it true? The presumption of particles circulating at the same orbital speed of the Earth appears at first to be only an excuse for "saving the theory."

However, we saw above that the mathematics of General Relativity and the observed Thirring-Lenz effect requires that there be some rotational motion in the vicinity of a rotating body. According to the primary assumptions of General Relativity, the Thirring-Lenz effect has no "basis." A superfluid aether would cause accelerations as a result of imparting a vortex spin on the aether field which would then accelerate the target body.

The sun is rotating rapidly in the direction of planetary (earth) orbits. According to General Relativity, the only solution that is not possible in such a situation is irrotational motion in the aether corpuscles. The key assumption in the argument that the earth "would impinge on more particles which are coming from its forward side than from its hind side" is based on non-circulating particles. According to General Relativity, this assumption is found to be invalid! Also, if the aether fluid is indeed a superfluid, once a rotation of the fluid is started it will continue without loss of energy.

The Feynman argument against the LeSage-type hypothesis was completely plausible, for there is no obvious reason to expect that the aether would be rotating along with the earth. But field rotation is both observed and a mathematical requirement of the superfluid vorticity in General Relativity. So, for the moment at least, our theory remains consistent with General Relativity.

This is not the only possible explanation for the earth not spiralling into the sun. The Feynman argument rests on the additional assumption that gravity (and the aether drag) is the only force acting on the earth's orbital motion. But -- in order to contract from a protostar -- the sun must have somehow lost most of its angular momentum to the planets. If this mechanism were the result of the rotating solar magnetic field, the solar field will interact with the magnetosphere of the earth (and the plasma within it). This interaction will lead to a transfer of angular momentum from the sun to the earth. In short -- all possible sources of orbital impulse must be examined before we throw out a superfluid aether.

The basis for Feynman's argument was the same as one made for the irrotational earth (geocentric cosmos), and dealt with by Galileo in his Dialog on Two World Systems in 1632. The argument went as follows:

According to (Claudius Ptolemy and Tycho Brahe), if the earth were moving (rotating) an object thrown vertically upward would not descend along the same line ..., the point on the earth under the object would have shifted while the object was in the air. Furthermore, if the earth were moving (rotating) from west to east, the direction required to explain the appearance of the heavens, then ... (p)eople on the earth would perpetually feel an east wind, just as a rider feels a wind in his face as he travels along. ...

Galileo had refuted the arguments ... in his Dialogue Concerning the Two Chief World Systems. Objects ... belong to the moving system of the earth, and as parts they participate in the motion of the whole in addition to their own observable motions."

Radner and Radner, Science and Unreason, Wadworth Publishing Company, 1982, p34

As the air moves with a rotating earth, so the aether moves with the orbiting earth. They are part of the same "world system." It is only because the aether is so much less noticeable than the air (to us) that we accept Feynman's argument without close examination. By General Relativity and the Thirring-Lenz effect, the aether MUST move around the rotating sun and the orbiting earth. A Feynman-type argument can only be used if it is demonstrated beyond any doubt that the two components are not part of the same "world system." Whenever one component is affected by the other they must be part of the same, coupled, world system -- and the interdependence cannot be dismissed without serious thought. In this case the wind affects the surface of the earth or the aether is presumed to affect the earth's orbit.

Even if the Thirring-Lenz effect has no bearing, there is also the gravitational "sling" argument. If gravity is the result of a superfluid aether, then the speed of propagation of gravity must be finite. If the speed of gravity is finite, then orbiting masses will accelerate out of orbit. This is supposedly due to the "lead" of the gravitational force, due to the past position of the second object. This is one "push" that could overcome or balance the "drag" of the aether. Proponents of GR state that it is only the "delicate balance" of GR that keeps the orbits from accelerating or decelerating.

Summary

Maxwell's equations were explicitly developed as fluid dynamical models, and require an underlying physical medium. Special relativity was derived from Maxwell's equations. General relativity is based on perfect fluid equations.

Thus, any theory based on one of these three theories implicitly retains all fluid dynamical properties. Any denial of an underlying physical medium by such a theorist is therefore hollow -- and merely shows ignorance on the part of

the practitioner concerning the history and derivation of the equations that are being used.

"Fundamental challenges to disciplines tend to come from outside. It is customary for students to be introduced to their fields of study gradually, as slowly unfolding mysteries, so that by the time they can see their subject as a whole, they have been so thoroughly imbued with conventional preconceptions and patterns of thought that they are extremely unlikely to be able to question its basic premises."

Martin Bernal *Black Athena: The Afroasiatic Roots of Classical Civilization*, Vol. I, 1987

THE ELECTROMAGNETIC FIELD & CLERK MAXWELL

ARTICLES BY ALBERT EINSTEIN & THOMAS F. TORRANCE

Introduction

This reference article is included in the aether compilation of articles for a number of reasons. Firstly, it was the understanding of Clerk Maxwell that there existed some form of luminiferous medium which bore the propagation of the electromagnetic field. Secondly, the nature of the electromagnetic field itself is the closest specification that man has made in relation to the nature of light - the medium of his highest physical sense - that of vision.

Thirdly, the summation by Albert Einstein of the work of Clerk Maxwell on the nature of the electromagnetic field is of outstanding resource. In a separate article, entitled Aether and the Theory of Relativity, there may be found a more direct discussion concerning the aether by Albert Einstein. The value of the article found below is its addressing the nature of light, and the scientific specifications thereof.

I am indebted to the the publishers of James Clerk Maxwell - A Dynamical Theory of the Electromagnetic Field - and in particular to its editor, Torrance, who has authored the introduction to this book, and thus the first of the two references which are produced below. They are presented here on a not-for-profit basis, and rather in an effort to provide information for those who know themselves as the students of life. There is currently one further resource which relates to the work of James Clerk Maxwell. It is the outline of a book which he had published in 1882 entitled Matter And Motion.

All the best for now,
Pete Brown
Southern Autumn of 97

James Clerk Maxwell

A Dynamic Theory of the Electromagnetic Field

Introduced and edited by T.F. Torrance (1982)

Three observations may now be offered in concluding this Introduction.

(1) Clerk Maxwell created for the first time a field theory which was independently testable against Newtonian force theories. He created a situation in which the dominance of Newtonian mechanics over the whole spectrum of physical science was called into question and decisive steps were taken in the direction of a non-mechanical thoroughly relational understanding of the intelligible connections immanent in the universe. No doubt Clerk Maxwell did not realise the far-reaching implications of his work which was to change the basic perspective and direction of physical science and alter our understanding of the world of space and time. With reference to Clerk Maxwell's two basic papers, *On Physical Lines of Force* and *A Dynamical Theory of the Electromagnetic Field*, Ivan Tolstoy has recently given us the following appraisal. 'For us, with our hundred or so years of perspective, these two papers - Maxwell's theory of electromagnetism - are a turning point in the history of science.

The theory is, first of all a synthesis - one of the greatest in the history of science. It unifies two kinds of force - the electric and the magnetic - under one: the electromagnetic field. This unification was the direct, logical consequence of Faraday's experimental work; it had a been begun by others - Ampere, Weber, W. Thomson. But Maxwell crystallized this, the first of the modern unified field theories and gave it the mathematical form which remains immortal under the name of Maxwell's equations - a system of relationships between changing electric and magnetic fields - a whole universe of electromagnetic phenomena, miraculously contained in a few lines of elegant mathematics.

(2) Clerk Maxwell's work was of profound conceptual importance for it had the effect of reorganising the epistemological and logical substructure of physical science, not only through his determination of the mathematical properties of radiation which has had immense implications for scientific technology, but through the way in which he conceived and developed the nature of the field and established the reality of the field as the underlying reality of all spatio-temporal phenomena. At this point we cannot do better than let Einstein himself speak.

'The formulation of these equations is the most important event in physics since Newton's time, not only because of their wealth of content, but also because they form a pattern for a new type of law. The characteristic features of Maxwell's equations, appearing in all other equations of modern physics, are summarized in one sentence. Maxwell's equations are laws representing the structure of the field... All space is the scene of these laws and not, as for mechanical laws, only points in which matter or charges are present.

Moreover, it should be pointed out, that since the epistemological form of Clerk Maxwell's general equations does not depend on the way in which the observer, or the person who measures the fields, is moving, they have the

effect of establishing the objectivity of scientific knowledge in a new and a profounder way than was possible in the post-Newtonian, and certainly, the post-Kantian, outlook upon the universe.

(3) Physical science as it stemmed from Clerk Maxwell's revolutionary ideas was left with a serious, and perhaps an ultimately irresolvable problem, of which, as we have seen, he himself seems to have been aware. This relates to the fact that although his equations expressed the mathematical properties of the energy intrinsic to the continuous field of space and time, he was unable to reconcile in a satisfactory manner, the ways in which the two basic forms of this energy, in respect of position and motion, manifest themselves. Thus, as Einstein has expressed it, while Clerk Maxwell's partial differential equations appeared as the natural expression of the primary realities of physics, in a particular area of theoretical physics,

'the continuous field appeared side by side with the material point as the representative of physical reality. This dualism has to this day not disappeared, disturbing as it must evidently be to any systematic mind.

Clerk Maxwell's problem remains with us in the difficulties that have emerged in the reconciliation of relativity theory and quantum theory, not to mention a unified field theory which will take in thermodynamics and gravity theory as well - although some way toward the solution may well lie along the line of thought which both Michael Faraday and Clerk Maxwell entertained, that the relations between particles in a field of force must be thought of as constituting, in part at least, what particles actually are. However, it is doubtful whether in the nature of the case the duality between particle and field can ever be completely removed any more than the distinction between the temporal and the spatial aspects of space-time.

Maxwell's Influence on the Development

of the Conception of Physical Reality

Albert Einstein

Written for the centenary of Maxwell's birth [1931]

The belief in an external world independent of the observing subject lies at the foundation of all natural science. However, since sense-perceptions only inform us about this external world, or physical reality, indirectly, it is only in a speculative way that it can be grasped by us. Consequently our conceptions of physical reality can never be final. We must always be ready to change these conceptions, i.e. the axiomatic basis of physics, in order to do justice to the facts of observation in the most complete way that is logically possible. In

actual fact, a glance at the development of physics shows that this axiomatic basis has met with radical changes from time to time.

The greatest change in the axiomatic basis of physics, and correspondingly in our conception of the structure of reality, since the foundation of theoretical physics through Newton, came about through the researches of Faraday and Maxwell on electromagnetic phenomena. In what follows we shall try to present this in a more precise way, while taking the earlier and later development into account.

In accordance with Newton's system, physical reality is characterised by concepts of space, time, the material point and force (interaction between material points). Physical events are to be thought of as movements according to law of material points in space. The material point is the only representative of reality in so far as it is subject to change. The concept of the material point is obviously due to observable bodies; one conceived of the material point on the analogy of movable bodies by omitting characteristics of extension, form, spatial locality, and all their 'inner' qualities, retaining only inertia, translation, and the additional concept of force. The material bodies which had psychologically given rise to the formation of the concept of 'material point' had now for their part to be conceived as a system of material points. It is to be noted that this theoretical system is essentially atomistic and mechanistic.

All happening was to be conceived of as purely mechanical, that is, merely as motions of material points according to Newton's laws of motion.

The most unsatisfactory aspect of this theoretical system - apart from the difficulty relating to the concept of 'absolute space' which has recently been brought back into the discussion - lay mainly in the doctrine of light, which Newton quite logically had also thought of as consisting of material points. Even at that time the question must already have been felt acutely: What happens to the material points that constitute light, when light itself is absorbed? Moreover, it is altogether unsatisfactory to introduce into the discussion two quite different kinds of material points which had to be put forward to represent ponderable matter and light. Then later on electrical corpuscles were added as a third sort with fundamentally different properties. Besides, it was a weakness in the basic structure that interacting forces had to be postulated quite arbitrarily to account for what happens. Nevertheless, this conception of reality accomplished a lot. How, then, did the conviction arise that it should be abandoned?

In order to give his system mathematical form at all, Newton had first to invent the concept of the differential quotient, and to draw up the laws of motion in the form of total differential equations - perhaps the greatest intellectual step that it has ever been given to one man to take. Partial differential equations were not needed for this, and Newton did not make any methodical use of

them. Partial differential equations were needed, however, for the formulation of the mechanics of deformable bodies; this is bound up with the fact that in such problems the way and the manner in which bodies were thought of as constructed out of material points did not play a significant part to begin with.

Thus the partial differential equation came into theoretical physics as a servant, but little by little it took on the role of master. This began in the nineteenth century, when under the pressure of observational facts the undulatory theory of light asserted itself. Light in empty space was conceived as a vibration of the ether, and it seemed idle to conceive of this in turn as a conglomeration of material points. Here for the first time partial differential equations appeared as the natural expression of the primary realities of physics. In a particular area of theoretical physics the continuous field appeared side by side with the material point as the representative of physical reality. This dualism has to this day not disappeared, disturbing as it must be to any systematic mind.

If the idea of physical reality had ceased to be purely atomistic, it still remained purely mechanistic for the time being. One still sought to interpret all happening as the motion of inert bodies: indeed one could not at all imagine any other way of conceiving of things. Then came the great revolution which will be linked with the names of Faraday, Maxwell, Hertz for all time. Maxwell had the lion's share in this revolution. He showed that the whole of what was known at that time about light and electromagnetic phenomena could be represented by his famous double system of partial differential equations, in which the electric and the magnetic fields made their appearance as dependent variables. To be sure Maxwell did try to find a way of grounding or justifying these equations through mechanical thought-models. However, he employed several models of this kind side by side, and took none of them really seriously, so that only the equations themselves appeared as the essential matter, and the field forces which appeared in them as ultimate entities not reducible to anything else. By the turn of the century the conception of the electromagnetic field as an irreducible entity was already generally established and serious theorists had given up confidence in the justification, or the possibility, of a mechanical foundation for Maxwell's equations. Soon, on the contrary an attempt was made to give a field-theoretical account of material points and their inertia with the help of Maxwell's field theory, but this attempt did not meet with any ultimate success.

If we disregard the important particular results which Maxwell's life work brought about in important areas of physics, and direct attention to the modification which the conception of physical reality experienced through him, we can say: Before Maxwell people thought of physical reality - in so far as it represented events in nature-as material points, whose changes consist only in motions which are subject to total differential equations. After Maxwell they

thought of physical reality as represented by continuous fields, not mechanically explicable, which are subject to partial differential equations. This change in the conception of reality is the most profound and the most fruitful that physics has experienced since Newton; but it must also be granted that the complete realisation of the programme implied in this idea has not by any means been carried out yet. The successful systems of physics, which have been set up since then, represent rather compromises between these two programmes, which because of their character as compromises bear the mark of what is provisional and logically incomplete, although in some areas they have made great advances. - Of these the first that must be mentioned is Lorentz's theory of electrons, in which the field and electric corpuscles appear beside one another as equivalent elements in the comprehension of reality. There followed the special and general theory of relativity which - although based entirely on field theory considerations-hitherto could not avoid the independent introduction of material points and total differential equations.

The last and most successful creation of theoretical physics, quantum mechanics, differs fundamentally in its principles from the two programmes which we will briefly designate as Newton's and Maxwell's. For the quantities which appear in its laws lay no claim to describe physical reality itself but only the probabilities for the occurrence of one of the physical realities to which attention is being directed. Dirac, to whom in my judgement. we are indebted for the most logically complete account of this theory rightly points to the fact that it would not be easy, for example. to give a theoretical description of a photon in such a way that there would be comprised in the description sufficient reason for a judgement as to whether the photon will pass a polarisator set obliquely in its path or not.

Nevertheless. I am inclined to think that physicists will not be satisfied in the long run with this kind of indirect description of reality, even if an adaptation of the theory to the demand of general relativity can be achieved in a satisfactory way. Then they must surely be brought back to the attempt to realise the programme which may suitably be designated as Maxwellian: a description of physical reality in terms of fields which satisfy partial differential equations in a way that is free from singularities.

BEYOND $E=mc^2$

**A FIRST GLIMPSE OF A POSTMODERN PHYSICS, IN WHICH
MASS, INERTIA AND GRAVITY ARISE FROM UNDERLYING
ELECTROMAGNETIC PROCESSES**

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The most famous of all equations must surely be $E=mc^2$. In popular culture that relation between energy and mass is virtually synonymous with relativity, and Einstein, its originator, has become a symbol of modern physics. The usual interpretation of the equation is that one kind of fundamental physical thing, mass (m in the equation), can be converted into a quite different kind of fundamental physical thing, energy (E in the equation), and vice versa; the two quantities are inextricably intertwined, related by the factor c^2 , the square of the velocity of light. The energy of the sun, for instance, comes from nuclear fusion, in which the nuclei of hydrogen atoms fuse together to become the nuclei of helium atoms. In the prevailing view, mass is lost in the fusion reaction, and as one popular astronomy textbook puts it, "The small fraction of mass that disappears in the process is converted into energy according to the formula $E=mc^2$."

Recent work by us and others now appears to offer a radically different insight into the relation $E=mc^2$, as well as into the very idea of mass itself. To put it simply, the concept of mass may be neither fundamental nor necessary in physics. In the view we will present, Einstein's formula is even more significant than physicists have realized. It is actually a statement about how much energy is required to give the appearance of a certain amount of mass, rather than about the conversion of one fundamental thing, energy, into another fundamental thing, mass.

Indeed, if that view is correct, there is no such thing as mass-only electric charge and energy, which together create the illusion of mass. The physical universe is made up of massless electric charges immersed in a vast, energetic, all-pervasive electromagnetic field. It is the interaction of those charges and the electromagnetic field that creates the appearance of mass. In other words, the magazine you now hold in your hands is massless; properly

understood, it is physically nothing more than a collection of electric charges embedded in a universal energetic electromagnetic field and acted on by the field in such a way as to make you think the magazine has the property of mass. Its apparent weight and solidity arise from the interactions of charges and field.

Besides recasting the prevailing view of mass, this idea would address one of the most profound problems of physics, the riddle of how gravity can be unified with the other three fundamental forces of nature. The electromagnetic force and the weak force, which is responsible for nuclear decay, have been shown to be two manifestations of a single force, appropriately called the electroweak force. There are tantalizing hints that the strong force, which binds nuclei together, will someday be unified with the electroweak force. But until now gravity has resisted all attempts at unification. If the new view is correct, however, gravity would not need to be separately unified. Just as mass would arise from the electromagnetic force, so would gravity.

What is mass? Two key properties define the concept of the mass of a given amount of matter, namely, its inertia and the gravitation to which the matter gives rise. Inertia was defined by Galileo as the property of matter that keeps an object in uniform motion once given an impetus, until the object is acted upon by some further impetus. Galileo's idea was generalized and quantified by Newton in his Principia. The tendency of an object to remain in uniform motion, and the tendency of the motion to change when impetus is applied, Newton expressed in one compact equation. The equation states that the acceleration a , or change of velocity, is proportional to the force F applied, where the constant of proportionality is the inertial mass m of the object in question: thus, $F=ma$.

In other words, inertial mass is the resistance an object offers to being accelerated when it is subjected to a force. In Newton's equation of motion, when the application of a force ceases, the acceleration goes to zero, and the object remains in uniform motion. Objects are assumed to resist acceleration, because that resistance is an innate property of matter.

But try as he might, Newton could not explain the origin of inertia. Imagine, he suggested, that the universe is empty except for a bucket partly filled with water. Furthermore, imagine the shape of the surface of the water: Is it flat? Then the water must be at rest. Is it curved, shaped in cross section like a parabolic reflector? Then the water must be rotating. But rotating with respect to what? That was the profound dilemma that Newton identified. If the universe were truly empty, as his thought experiment required, there would be no background against which the rotation could be measured. But because the shape of the water surface signals whether a rotation is taking place, Newton

concluded that there is a fundamental spatial frame of reference, an "absolute space."

Some 200 years later the nineteenth-century Austrian physicist and philosopher Ernst Mach took a contrary view. To Mach, Newton's thought experiment demonstrated the absurdity of the idea of absolute space. The shape of the water in a rotating bucket, Mach held, was conferred, somehow, through the presence of all the other matter in the universe. Thus Mach agreed with Newton that the property of inertia creates the need for a reference frame; he simply disagreed that such a reference frame could exist as a distinct, absolute entity. Distant matter, however, could define the reference frame. Unfortunately, his conjecture, which has come to be known as Mach's principle, remains more of a philosophical statement than a testable scientific proposition.

In the early twentieth century a number of investigators, including Max Abraham, Hendrik Antoon Lorentz and Henri Poincare, suggested that inertial mass might arise from an effect called electrostatic self-energy. Any charged particle—the electron, for instance—possesses a certain quantity of electric charge. The charge is the source of an electric field, which carries energy—the electrostatic self-energy. It was proposed that the electrostatic self-energy might correspond to the inertial mass of the charged particle, through the equation $E=mc^2$. But the theoretical mass of the electrostatic electron derived from the equation is many orders of magnitude larger than the actual observed mass of the electron, and the self-repulsion of the electrostatic forces would quickly disperse the electrostatic electron. Hence the theory fails.

Our work suggests inertia is a property arising out of the vast, all-pervasive electromagnetic field we mentioned earlier, which is called the zero-point field (ZPF). The name comes from the fact that the field is held to exist in a vacuum—what is commonly thought of as "empty" space—even at the temperature of absolute zero, at which all thermal radiation is absent. The background energy of the vacuum serves as the reference, or zero point, for all processes. To understand how the ZPF might give rise to inertia, one must understand something about the nature of the field itself.

Theoretical considerations indicate that the ZPF should be a background sea of electromagnetic radiation that is both uniform and isotropic (the same in all directions). The reader may already be familiar with a somewhat similar concept: the remnant radiation from the big bang. According to big bang cosmology, the universe began with a titanic explosion, which gave rise to hot, energetic radiation distributed throughout the infant universe. As the universe expanded and cooled, the radiation became much less energetic, but it still pervades space as a faint and nearly isotropic background of microwave radiation.

Like the cosmic microwave background, the ZPF is a sea of radiation that fills the entire universe. There is a major difference, however. The cosmic microwave background has a rather feeble spectrum identical with the spectrum of an object in thermal equilibrium at a temperature of only 2.76 degrees Celsius above absolute zero. In contrast, the ZPF is a highly energetic emission whose predicted radiation spectrum departs radically from the spectrum of an object in thermal equilibrium. Instead of trailing off at high frequencies, the energy of the ZPF continues to rise sharply with the frequency of the radiation. Quantitatively, the energy density is proportional to the cube of the frequency; double the frequency, and the energy increases by a factor of eight. At what frequency the ZPF spectrum finally cuts off or loses its ability to interact with matter are important and still unresolved issues.

A more profound difference between the cosmic microwave background and the ZPF is a result of the origin of the two emissions. When you switch on a lightbulb, the source of the light emission is clear; it is the heat produced by an electric current in the filament. The source of the cosmic microwave background can also be traced to known physical phenomena, namely, the heat radiation associated with the big bang, as modified by the later expansion and cooling of the universe. The origin of the ZPF is more esoteric. In fact, two distinct views about it exist today.

The conventional view traces the ZPF to the laws of quantum mechanics, the theory forged early in the present century to describe the atom. Any electromagnetic field is characterized by the frequency, polarization and direction of propagation of its radiation. A set of values for those three quantities defines a single so-called mode of the field. Every possible mode can be populated by an arbitrary number of photons, the fundamental quanta of electromagnetic radiation. But according to the probabilities calculated in quantum mechanics, even at its minimum energy, each mode will contain one photon half the time and no photons the other half the time. In a field of zero energy each mode would, with certainty, contain no photons, but that is impossible because of the equal probability that each mode also contains one photon. Thus every mode acts, on average, as if it were populated with at least one-half photon (in addition to whatever other natural or man-made radiation happens to be present).

All such modes add up quickly. Since the energy density of the ZPF increases as the cube of the frequency, the amount of energy making up the ZPF is enormous. That energy, in the conventional view, is simply forced into existence by the laws of quantum mechanics. Not surprisingly, it is regarded in quantum fashion as sometimes real and sometimes virtual, depending on the problem at hand.

The competing theory for the origin of the ZPF comes from what has heretofore been an obscure discipline within physics known as stochastic

electrodynamics, a modern version of much earlier twentieth-century investigations by Einstein, Max Planck, Walther Nernst, Ludwig Hopf and Otto Stern. Stochastic electrodynamics postulates that the ZPF is as real as any other radiation field. In such a view the existence of a real ZPF is as fundamental as the existence of the universe itself. The only difference between stochastic electrodynamics and ordinary classical physics is the single assumption of the presence of this all-pervasive, real ZPF, which happens to be an intrinsic part of the universe.

One justification for making such an assumption is that by adding the ZPF to classical physics many quantum phenomena can be derived without invoking the usual laws or logic of quantum mechanics. It is premature to claim that all quantum phenomena could be explained by stochastic electrodynamics (that is, classical physics plus the ZPF), but that claim may one day turn out to be the case. In that event, one would have to make a choice. One could accept the laws of classical physics as only partly true, with a wholly different set of quantum laws required to complete the laws of physics; that is essentially what is done in physics now. Or one could accept the laws of classical physics as the only necessary laws, provided they are supplemented by the presence of the ZPF.

Whether the ZPF arises from quantum laws or is simply an intrinsic part of the universe, an important question remains: Why do people not sense the presence of the radiation if indeed it is made up of real electromagnetic waves spanning the spectrum of radio waves, light and X rays? The idea that space could be filled with a vast sea of energy does seem to contradict everyday experience. The answer to the question lies in the utter uniformity and isotropy of the field. There is no way to sense something that is absolutely the same everywhere, outside and inside everything. To put the matter in everyday terms, if you lie perfectly still in a tub of water at body temperature, you cannot feel the heat of the water.

Motion through a medium almost always gives rise to asymmetries, which then makes it possible to detect the medium. But in the case of the ZPF, motion through space at a constant velocity does not make the field detectable, because the field has the property of being "Lorentz invariant." (Lorentz invariance is a critical difference between the modern ZPF and nineteenth-century concepts of an ether.) The field becomes detectable only when a body is accelerated through space. In the mid-1970s the physicists Paul C. W. Davies, now at the University of Adelaide in Australia, and William G. Unruh, now at the University of British Columbia, showed that as a moving observer accelerates through the ZPF, the ZPF spectrum becomes distorted, and the distortion increases with increasing acceleration. Can the distortion be seen? Yes indeed, but not with one's eyes, because the energies involved are minute.

Although the distortion is small, it is extremely important: our analysis shows that it is the origin of inertia. In an article published last February in *Physical Review A*, we showed that when an electromagnetically interacting particle is accelerated through the ZPF, a force is exerted on the charge; the force is directly proportional to the acceleration but acts in the direction opposite to it. In other words, the charge experiences an electromagnetic force as resistance to acceleration. We interpret the resistance associated with the charge as the very inertia Newton regarded as an innate property of matter. Note that we do not say, "associated with the mass of the particle." In our formulation, the m in Newton's second law of motion, $F=ma$, becomes nothing more than a coupling constant between acceleration and an external electromagnetic force. Thus what we are proposing is that Newton's second law can be derived from the laws of electrodynamics, provided one assumes an underlying zero-point field.

Our work suggests that the conventional Newtonian idea of mass must be boldly reinterpreted. If we are correct, physical theory need no longer suppose that there is something called mass having an innate property, inertia, that resists acceleration; what is really happening, instead, is that an electromagnetic force acts on the charge inside matter to create the effect of inertia. Indeed, it appears that the more parsimonious interpretation is not even that there is charge lurking "inside matter," but that there is only charge. The presence of charge and its interaction with the ZPF creates the forces we all experience and attribute to the existence of matter. Our interpretation would apply even to an electrically neutral particle such as the neutron, because the neutron, at the most fundamental level, is thought to be made up of smaller particles called quarks, which do carry electric charge.

We have had little to say so far about the second key property for the concept of mass, the gravitation to which matter gives rise. But experimental evidence shows that an object's inertial mass, or its resistance to acceleration, is equivalent to the object's gravitational mass, or its mass in a gravitational field. Einstein's general theory of relativity is based on the assumption that inertial and gravitational mass are equivalent and indistinguishable—the so-called principle of equivalence. Hence it stands to reason that if the ZPF gives rise to the phenomenon of inertia, it must also in some way generate the effect of gravity. This audacious idea was proposed as early as 1968 by the Russian physicist and dissident Andrei D. Sakharov, but he never fully developed the concept into a scientific theory.

In 1989 the idea was taken up by one of us (Puthoff) and formulated within the framework of stochastic electrodynamics into a preliminary but quantifiable, nonrelativistic representation of Newtonian gravitation. The underlying principle is remarkably intuitive. If a charged particle is subjected to ZPF interactions, it will be forced to fluctuate in response to the random jostlings of the

electromagnetic waves of the ZPF. Moreover, since the ZPF is all-pervasive, charged particles everywhere in the universe will be forced to fluctuate. Now a basic result from classical electrodynamics is that a fluctuating electric charge emits an electromagnetic radiation field. The result is that all charges in the universe will emit secondary electromagnetic fields in response to their interactions with the primary field, the ZPF.

The secondary electromagnetic fields turn out to have a remarkable property. Between any two particles they give rise to an attractive force. The force is much weaker than the ordinary attractive or repulsive forces between two stationary electric charges, and it is always attractive, whether the charges are positive or negative. The result is that the secondary fields give rise to an attractive force we propose may be identified with gravity.

It is important to note that the fluctuations are relativistic-that is, the charges move at velocities at or close to the speed of light. The energy associated with the fluctuations-which for historical reasons is given the German name *zitterbewegung*, or trembling movement-is interpreted as the energy equivalent of gravitational rest mass. Since the gravitational force is caused by the trembling motion, there is no need to speak any longer of a gravitational mass as the source of gravitation. The source of gravitation is the driven motion of a charge, not the attractive power of the thing physicists are used to thinking of as mass. To interpret Einstein's equation $E=mc^2$, we would say that mass is not equivalent to energy. Mass is energy.

Naturally there are a host of objections that have been or can be raised to our radical interpretation of mass. One important objection is that for gravity our model so far is nonrelativistic, whereas the *zitterbewegung* motions are relativistic. Another possible objection is that we treat the ZPF as real, not virtual, as conventional quantum theory does-even though real, measurable forces can be attributed to it. One such force is the so-called Casimir force between two parallel plates.

It is also claimed that if the ZPF really exists, it would be such an enormous source of gravitational force that the radius of curvature of the universe would be several orders of magnitude smaller than the nucleus of an atom. Of course, such a conclusion directly conflicts with everyday experience. The fallacy in the argument is that in the Sakharov-Puthoff model the ZPF as a whole would not itself gravitate. The gravitational force results from perturbations of the ZPF in the presence of matter. In the Sakharov-Puthoff model, then, the uniform ZPF is not a gravitational source and hence would not contribute to curving the universe.

A third large question also remains to be answered. How can our theory of Newtonian-like gravity be reconciled with twentieth-century measurements of effects predicted only from general relativity? How, for example, can our theory

account for the gravitational deflection of light, the measurement of which in 1919 served as the first proof of general relativity? On that point we can only conjecture. Sakharov suggested accounting for the effects of general relativity by introducing the concept of an "elasticity of space," analogous to the well-known curvature of space-time. The answer could also lie in the proper treatment of the so-called Dirac sea of particle-antiparticle pairs. The question of general relativistic effects, however, is a valid concern that legitimately challenges the interrelated ZPF concepts of gravity and inertia.

Serious as the objection appears to be, we propose that it is prudent to suspend judgment. A great deal of work lies ahead to test and refine our concepts. We and others will continue to study the problem, and in due course the theoretical foundations of those proposals will either be verified or be shown to contain some irreparable flaw. As controversial as the ideas and their implications might be, however, we are encouraged that we are on the right track because of a second analysis now being carried out by one of us (Rueda). In the new analysis it appears that you obtain the same electromagnetic relation between force and acceleration as you get in the original analysis, yet the approach is entirely different. We also submit that a theory that offers new insights with elegance and simplicity is a compelling approach to reality, and we suggest that our view of inertial and gravitational mass has a certain elegance and simplicity.

If our ideas prove to be correct, they will point to revisions in the understanding of physics at the most fundamental level. Even if our approach based on stochastic electrodynamics turns out to be flawed, the idea that the vacuum is involved in the creation of inertia is bound to stay. Perhaps even bolder than the concepts themselves are their implications. If inertia and gravity are like other manifestations of electromagnetic phenomena, it might someday be possible to manipulate them by advanced engineering techniques. That possibility, however remote, makes a compelling case for pressing on with the work.

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A QUANTUM BROOM SWEEPS CLEAN

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Pity the astronomers and physicists. They toss and turn at night wondering why the universe is lumpy, and rack their brains trying to unify the four fundamental forces of nature. Now a new theory, which claims to solve both problems at once, will probably cost them more sleep.

The most fundamental equation in physics is the relation between force, mass, and acceleration which Isaac Newton postulated over three centuries ago: $F=ma$. It defines the concept of inertia, the resistance that an object puts up to a change in motion. To make something move faster or slower, you need to apply a force, and the force you need to apply is greater for larger masses. This is such a simple, intuitive fact that it seems more foolish than profound to ask, Why is it true? Why do objects have inertia?

As fundamental as this question is, a convincing answer has eluded the likes of Albert Einstein and Richard Feynman. Ideas about inertia have fallen into two schools. Newton himself argued it is an intrinsic property of matter, capable of no further explanation. To tell whether an object possesses inertia, you do not have to measure its motion with respect to external reference points; you need only look for the telltale distortions that occur whenever a body that has inertia accelerates. Rotation, for example, is one form of acceleration. As Earth rotates, its equator bulges out -- a dead giveaway that our planet possesses inertia.

Newton's idea of absolute acceleration, one that did not need external objects to define it, bothered many scientists -- among them the 19th-century Austrian physicist and philosopher Ernst Mach, whose ideas helped to inspire Einstein's theories of relativity. Mach argued that all motion is relative. If Earth were all alone in a hypothetical universe devoid of other matter, how would it know whether it was rotating? And if Earth did not know whether it was rotating,

how would its equator know whether to bulge out? Mach resolved this paradox by concluding that the solitary Earth could not have any inertia. Somehow, the Earth's inertia is generated by the presence of other matter in the universe.

But how? Einstein thought that his general theory of relativity would embody Mach's principle, but it turned out not to. The source of inertia remained a mystery until, we believe, 1994 -- when, together with Harold Puthoff of the Institute for Advanced Studies in Austin, Texas, we proposed a radical theory: that inertia is an electromagnetic force that switches on whenever an object accelerates through space. It turns out that Mach was almost right. In our theory, inertia does depend on an external frame of reference, but this frame of reference is provided not by the other bodies in the universe, but by an electromagnetic field that pervades the cosmos. This field, in turn, arises because of quantum mechanical ferment in the vacuum -- a subject shaping up as a major theme of 21st-century physics.

Last year, we realized that the vacuum also might explain another great mystery of modern science: how the universe, at the largest scales, came to look like a whiffle ball. The honeycombed arrangement of galaxy clusters may hold the key to understanding how inertia, gravity, and mass came to be.

Sponges and Swiss Cheese

Four years ago, the NASA Cosmic Background Explorer detected blemishes in the microwave afterglow of the Big Bang. Astronomers were relieved. It was the first evidence that the early universe was not perfectly smooth and uniform [see "New Image of the Universe Soon After Creation," May/June 1992, p. 91]. Perfect uniformity would have left no way for cosmologists to explain how the lumpy present-day universe could arise from utterly homogeneous primordial stuff. Yet the COBE discovery accounted for only the highest level of inhomogeneity, on scales of 1 to 2 billion light-years (see images on p. 13). The largest structures known today in the universe are 10 times smaller.

Those structures are the great voids and sheets. Astronomers have known for some time that galaxies are concentrated into enormous clusters, but in the past decade, observers have discovered that the clusters are themselves concentrated into vast sheets, or walls. In between the walls are giant voids almost free of galaxies (see diagram above). The size of the cosmic voids ranges from tens to hundreds of millions of light-years. On these scales, the universe looks like Swiss cheese or a sponge: more hole than substance [see "Mapping the Universe," May/June 1990, p. 66].

How did this superstructure come about? Gravitation can explain the clumping if you assume the universe had just the right mixture of ordinary matter, cold dark matter, and hot dark matter. But this leaves astronomers a bit

uneasy. After all, we do not know what the dark matter is or whether it could exist in the necessary amounts. The recent announcement that white dwarfs may comprise half the dark matter in our galaxy does not help, because the cosmological dark matter would have had to reside outside galaxies and consist of material entirely unlike ordinary atoms.

Under these circumstances, the prudent thing to do is to examine other possible explanations, to search for the dark horse in addition to the dark matter. Can we account for the structures without having to populate the universe with unknown kinds of matter?

Deep intergalactic space, where the large-scale structures began to form, is a cosmic desert. Out there, the density of gas is low, so low that gas particles are subject only to minute forces exerted by the vacuum that surrounds them. The word vacuum innocently implies "empty," but nothing in quantum mechanics is ever so straightforward. The vacuum of modern physics is far from empty -- quite the opposite. It is a seething soup of subatomic particles and energy fields bubbling in and out of existence, a cauldron where the very notions of "space" and "time" may take on their meaning.

The not-so-empty vacuum is a consequence of the fact -- recognized by German physicist Werner Heisenberg in 1927 -- that you can never remove all the energy from anything. Take an electromagnetic field. It consists of photons, individual packets of energy each in a state defined by its direction, frequency, and polarization. Try as you might, you could never remove all the photons from any given state. According to the principles of quantum mechanics, every state must have a minimum population of either zero or one photon, with equal probability. The average of zero and one is one-half. Therefore there must be, on average, the equivalent of at least half a photon in every possible state.

Half a Photon Here, Half a Photon There

Half a photon in each state is not much -- a 100-watt light bulb puts out 100 billion billion photons every second -- but there are countless possible states. The result is a vast sea of radiation underlying the universe. All those virtual photons constitute the electromagnetic zero-point field, so named because it is present even at a temperature of absolute zero. In the deepest reaches of intergalactic space, where particles are so widely spaced that their mutual interactions are weak, this irreducible radiation field comes into play. In 1910, about halfway between the publication of special and general relativity, Einstein and his colleague Ludwig Hopf investigated how a thin gas would react when immersed in an electromagnetic radiation field. The radiation, they found, would have two counteracting effects on each gas particle. The particle would jiggle as photons bombarded it at random, but its motion would be opposed by a drag force due to the Doppler effect. The Doppler effect would stiffen the

resistance of photons in the direction that the particle was trying to move. The particle would smack head-on into blueshifted photons, which, being more energetic than the photons from other directions, would push it back the way it came. This drag force would prevent the random jiggles of the gas particle from developing into net motion.

The Einstein-Hopf process would be an interesting, but irrelevant, curiosity were it not for one peculiarity that sets the electromagnetic quantum vacuum apart from other radiation fields: the shape of its spectrum. The shape is exactly proportional to the frequency cubed -- precisely the right shape to be "Lorentz invariant." A spectrum with this shape does not produce a Doppler effect. The photons that a gas particle meets head-on in the quantum vacuum are no more energetic than those that strike the particle from behind. Consequently, the photons can offer no concerted resistance to uniform motion. (The spectrum and directional distribution of photons, however, do change for particles that are accelerating; this is the origin of inertia in our theory, as discussed in the box on p. 15.)

This idiosyncrasy of the vacuum electromagnetic field throws the Einstein-Hopf process out of balance (see figure on p. 14). Once gas particles are set in motion by the random fluctuations of the electromagnetic field, nothing can stop them. Over millions of years they accelerate steadily, reaching velocities near to that of light and moving across astronomical distances.

Astrophysicists are no strangers to this mechanism. Twenty years ago, one of us proposed it as a possible source of the most energetic cosmic rays. Most cosmic rays consist of electrons, protons, and ions, but those of extremely high energy are missing the electrons. The Einstein-Hopf process would explain this, because it operates more efficiently on protons and ions than on electrons. What no one had considered was that this process could also segregate matter on a cosmological scale.

When we first looked into the matter, the Einstein-Hopf process sounded too good to be true. By transferring energy from virtual photons into real particles, would the process yield something for nothing? To check, we teamed up with IBM physicist Daniel Cole, an expert on the quantum vacuum. For over five years, Cole had been assessing whether theories of the vacuum violate any basic principles, such as the conservation of mass-energy or the second law of thermodynamics. He was able to find nothing amiss with the quantum Einstein-Hopf mechanism.

Emptiness Begets Emptiness

The Einstein-Hopf process works best in places where particles hardly ever collide with each other, since collisions prevent the particles from building up speed. The less matter there is, the more the matter wants to go

someplace else. Thus the tendency is for regions of low density to empty out even more, and for regions of high density to become denser. This is exactly the sort of snowball effect that cosmologists have been looking for to explain how matter congregated to form sheets and walls. At some point, the acceleration must have come to an end, or else all matter would have clumped into a single mega-galaxy. We believe that the end drew near when the agglomerating sheets developed appreciable magnetic fields. As the particles scurried into sheets, they dragged along their primordial magnetic fields. Those fields piled up, creating a magnetic pressure that ultimately balanced the Einstein-Hopf evacuation process. Gravity took over to form smaller structures, such as galaxies. The end result, we proposed last spring in *The Astrophysical Journal*, was the honeycombed structure of the universe.

The theory rests on many assumptions, and the one that worries us is the most fundamental: that the quantum vacuum produces a real electromagnetic field. Physicists normally treat the virtual photons as just that: virtual, hence unable to produce any far-reaching real effects. But numerous experiments indicate the field may indeed influence matter. The quantum vacuum creates an attraction between neutral parallel plates, as predicted by Dutch physicist Hendrick Casimir in 1948 and confirmed experimentally several years later. The interaction of the vacuum electromagnetic field with electrons causes a shift of hydrogen spectral lines, as discovered by American physicists Willis Lamb Jr. and Robert Retherford in 1947 and explained later that year by Hans Bethe. And the spontaneous emission of photons can be altered by changing the electromagnetic environment of atoms; this suggests that "spontaneous" emission is actually stimulated by the fluctuations of the vacuum.

If the zero-point field is real, it should be possible to reproduce the Einstein-Hopf process in the laboratory. The main obstacle would be achieving densities comparable to those in the cosmic voids: less than one particle per cubic meter. But if we could even approximate this, the effect might be measurable. One possibility would be to create an extremely low temperature magnetic trap and inject anti-protons into it. If the Einstein-Hopf process ejected the anti-protons, the experimenter should see them annihilate with protons in the matter surrounding the trap.

The idea that the zero-point field might really exist dates to the early 20th century, when there was not yet a clear division between classical and quantum physics. Quantum mechanics emerged from a radical, and unsupported, assumption that German physicist Max Planck made in 1900: that the energy of a system can only take on certain discrete, or quantized, values. >From this hypothesis, he was able to explain the blackbody spectrum of the light that stars and other glowing bodies give off. Planck searched for something to explain the quantization, and one possibility he considered was

that space is filled with unseen energy, a proposal also made by Walther Nernst in 1916.

During the 1920s, quantum mechanics proved so successful that physicists abandoned the search for an underlying cause of quantization. Quantization, like inertia, came to be regarded as just a given, a new law of nature. But in a series of papers beginning in 1969, Timothy Boyer appears to have vindicated Planck by deriving the blackbody spectrum directly from classical physics, without quantization -- by positing a background zero-point field. This reopens the questions that concerned Planck.

Is it possible that quantum mechanics is classical physics done in the presence of a zero-point field? Could the counterintuitive laws of quantum physics someday go the way of Ptolemaic epicycles? Quantum mechanics is certainly successful in terms of predicting observations, but so was Ptolemaic astronomy. In fact, the Ptolemaic system predicted planetary positions much better than Nicolaus Copernicus's initial theory. If astronomers had simply rejected the Copernican model, rather than worked to fix its shortcomings, we would still think Earth is the center of the universe.

As Planck did when he first derived the blackbody spectrum, we have taken a pragmatic approach: suppose that the quantum vacuum does produce real effects and consider the implications. Many new theories are ad hoc, conjured up to explain one thing and unable to explain anything else. The fact that the zero-point field might account for inertia, gravity, quantization, and, now, cosmic voids indicates that it is worth investigating.

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Illustration captions

An astrophysical Genesis. More precisely, this is a map of the cosmic microwave background radiation, which reflects the distribution of matter shortly after the Big Bang. Darker areas had a higher density, brighter areas a lower density. NASA released a similar map in 1992, but it was based on preliminary measurements, which were so prone to noise that scientists could not be certain what was real. This latest map, released in January, contains more signal than noise. Even the smallest feature on the map is far larger than the largest structure astronomers see in the universe today. Images courtesy of Charles L. Bennett, NASA Goddard Space Flight Center.

Holes. The universe is full of holes. The regions shown on this diagram, which depicts a cube 500 million light-years on a side, are all but empty of luminous matter. These voids interconnect like the holes in your kitchen sponge. This diagram is based on an early-1990s redshift survey of infrared galaxies by Queen Mary College, the University of Durham, Oxford University, and the University of Toronto. Our Milky Way is at the center. Diagram courtesy of Carlos S. Frenk.

The Einstein-Hopf process. In a near-vacuum, collisions between gas particles are rare; collisions between particles and photons are more important. The photons are part of whatever electromagnetic field the particles happen to be immersed in. These photons are always hitting each particle from all sides, but not with equal strength. Those that hit a moving particle head-on are more energetic than those striking from behind, because of the Doppler effect. This imbalance automatically keeps the particle velocities in check (top). There is one exception: If the dominant electromagnetic field is the zero-point field, the spectrum of the field cancels out the Doppler effect, so that photons striking head-on are no more energetic than any other photons (bottom). As a result, the particles are free to move without restraint. Diagrams by Bernhard M. Haisch.

The Illusion of Mass

Maybe there is no such thing as "mass" -- only charge, which gives the illusion of mass when it is immersed in the quantum vacuum. It is an audacious idea, but one that would unify gravitation with the other fundamental forces of nature. Physicists universally accept the reality of the quantum vacuum, a sea of virtual particles and photons that wink in and out of existence too fast to be seen. But physicists are less confident that the virtual photons could create a real electromagnetic field. For starters, this zero-point field would raise problems with general relativity.

Einstein's theory states that energy produces gravity in the same way that matter does. Just as a planet attracts other bodies gravitationally, an electromagnetic field attracts bodies gravitationally. A uniform zero-point field

that filled the universe would be an enormous source of gravitation -- so enormous that it should reduce the universe to microscopic size. This is clearly not the case.

Two linked theories have been proposed to resolve this paradox. If correct, they would constitute a paradigm shift in our view of matter itself. The first theory grew out of a suggestion made by the Russian physicist Andrei Sakharov in 1968 that gravity could originate in the quantum vacuum. Harold Puthoff published a quantitative, albeit preliminary, development of this idea in 1989. According to his theory, the zero-point field would cause charged particles, such as the electron or the quarks inside protons and neutrons, to oscillate. Whenever a charged particle oscillates, it emits electromagnetic waves of its own. These secondary fields would attract other charged particles.

If true, this theory would unify gravity with electromagnetism -- an unexpected resolution to the long search for a unified theory. It would neatly answer the general relativity paradox. In this view, gravitation is caused by secondary fields induced by the zero-point field; the zero-point field, in and of itself, cannot produce gravitation.

The second theory is our proposed mechanism for inertia. Einstein's principle of equivalence tells us that inertial and gravitational mass are the same. If gravitation is electromagnetic, inertia must be, too. This implies a complete rethinking of what matter really is.

The zero-point field is completely uniform for observers in uniform motion. But it is asymmetric for observers in accelerated motion. In 1994, we and Puthoff examined a phenomenon no one had thought to investigate before: how the magnetic component of the zero-point field interacts with matter during acceleration. The result was surprising, to say the least. The magnetic Lorentz force opposed acceleration with a strength that varied in direct proportion to the magnitude of the acceleration (see figure). It looked like a derivation of Newton's second law, $F=ma$, heretofore considered an underivable postulate.

What we feel and interpret as "mass" is, in this theory, an electromagnetic resistance arising out of the zero-point field. If it is true that mass is a consequence of charge, rather than an inherent property of matter, it might be possible (in the distant future) to build anti-gravity devices that would switch off the inertia of objects.

Are there objections to this theory? Certainly. We propose it not as a done-deal, but as a new approach to long-standing, unresolved fundamental problems. There are two major reservations. First, we treated the quantum vacuum as if it were a perfectly real electromagnetic field. The available evidence on this issue is ambiguous, and more experiments need to be done -- ranging from laboratory measurements of the Casimir force to astronomical observations of large-scale structure in the universe.

Second, even our simple model demanded a complex mathematical analysis, which is difficult to verify. For instance, we ignored non-electromagnetic vacuum fields, such as those associated with the gluon particles that bind quarks together. We are now completing a different approach that avoids this and other problems, and the preliminary results have confirmed the first approach. We hope that more researchers will look into these problems, drawn by the appeal of unsuspected deep connections.

Illustration caption

The origin of inertia? Quantum mechanics predicts that photons are constantly flitting on and off the stage of existence. These photons are "virtual" in that each survives so short a time that the rest of us hardly notice. Collectively, however, they have observable effects, one of which was predicted by physicists Paul Davies and William Unruh in the mid-1970s and studied in detail by the authors. To a particle sitting still or moving uniformly, the field of virtual photons looks the same in all directions (top left). But as the particle begins to accelerate, the field ceases to look the same in the fore and aft directions (top center). For faster accelerations, the asymmetry worsens (top right). Physicists had thought the Davies-Unruh effect was an esoteric curiosity significant only near black holes. But the authors have found that the asymmetry creates a force similar to the radiation pressure that pushes cometary dust tails away from the Sun. This force always opposes the acceleration (bottom). Voilà, inertia. Diagrams by Bernhard M. Haisch.

THE INFLUENCE OF VEDIC PHILOSOPHY ON NIKOLA TESLA'S UNDERSTANDING OF FREE ENERGY

BY TOBY GROTZ

Abstract

Nikola Tesla used ancient Sanskrit terminology in his descriptions of natural phenomena. As early as 1891 Tesla described the universe as a kinetic system filled with energy which could be harnessed at any location. His concepts during the following years were greatly influenced by the teachings of Swami Vivekananda. Swami Vivekananda was the first of a succession of eastern yogi's who brought Vedic philosophy and religion to the west. After meeting the Swami and after continued study of the Eastern view of the mechanisms driving the material world, Tesla began using the Sanskrit words Akasha, Prana, and the concept of a luminiferous ether to describe the source, existence and construction of matter. This paper will trace the development of Tesla's understanding of Vedic Science, his correspondence with Lord Kelvin concerning these matters, and the relation between Tesla and Walter Russell and other turn of the century scientists concerning advanced understanding of physics. Finally, after being obscured for many years, the author will give a description of what he believes is the pre-requisite for the free energy systems envisioned by Tesla.

Tesla's Earlier Description of the Physical Universe

By the year 1891, Nikola Tesla had invented many useful devices. These included a system of arc lighting (1886), the alternating current motor, power generation and transmission systems (1888), systems of electrical conversion and distribution by oscillatory discharges (1889), and a generator of high frequency currents (1890), to name a few. The most well known patent centers around an inspiration that occurred while walking with a friend in a park in Budapest, Hungary. It was while observing the sunset that Tesla had a vision of how rotating electromagnetic fields could be used in a new form of electric motor. his led to the well known system of alternating current power distribution. In 1891 however, Tesla patented what one day may become his most famous invention. It is the basis for the wireless transmission of electrical power and is know as the Tesla Coil Transformer. It was during this year that

Tesla made the following comments during a speech before the American Institute of Electrical Engineers:

"Ere many generations pass, our machinery will be driven by a power obtainable at any point in the universe. This idea is not novel... We find it in the delightful myth of Antheus, who derives power from the earth; we find it among the subtle speculations of one of your splendid mathematicians... Throughout space there is energy. Is this energy static or kinetic.? If static our hopes are in vain; if kinetic - and this we know it is, for certain - then it is a mere question of time when men will succeed in attaching their machinery to the very wheelwork of nature." [1]

This description of the physical mechanisms of the universe was given before Tesla became familiar with the Vedic science of the eastern Nations of India, Tibet, and Nepal. This science was first popularized in the United States and the west during the three year visit of Swami Vivekananda.

Vedic Science and Swami Vivekananda

The Vedas are a collection of writings consisting of hymns, prayers, myths, historical accounting, dissertations on science, and the nature of reality, which date back at least 5,000 years. The nature of matter, antimatter, and the make up of atomic structure are described in the Vedas. The language of the Vedas is known as Sanskrit. The origin of Sanskrit is not fully understood. Western scholars suggest that it was brought into the Himalayas and thence south into India by the southward migrations of the Aryan culture. Paramahansa Yogananda and other historians however do not subscribe to that theory, pointing out that there is no evidence within India to substantiate such claims. [2]

There are words in Sanskrit that describe concepts totally foreign to the western mind. Single words may require a full paragraph for translation into English. Having studied Sanskrit for a brief period during the late 70's, it finally occurred to this writer that Tesla's use of Vedic terminology could provide a key to understanding his view of electromagnetism and the nature of the universe. But where did Tesla learn Vedic concepts and Sanskrit terminology? A review of the well known biographies by Cheney, Hunt and Draper, and O'Neil [3], [4], [5], reveal no mention of Tesla's knowledge of Sanskrit. O'Neal however includes the following excerpt from an unpublished article called Man's Greatest Achievement:

"There manifests itself in the fully developed being , Man, a desire mysterious, inscrutable and irresistible: to imitate nature, to create, to work himself the wonders he perceives.... Long ago he recognized that all perceptible matter comes from a primary substance, or tenuity beyond conception, filling all space, the Akasha or luminiferous ether, which is acted

upon by the life giving Prana or creative force, calling into existence, in never ending cycles all things and phenomena. The primary substance, thrown into infinitesimal whirls of prodigious velocity, becomes gross matter; the force subsiding, the motion ceases and matter disappears, reverting to the primary substance."

According to Leland Anderson the article was written May 13th, 1907. Anderson also suggested that it was through association with Swami Vivekananda that Tesla may have come into contact with Sanskrit terminology and that John Dobson of the San Francisco Sidewalk Astronomers Association had researched that association. [6]

Swami Vivekananda was born in Calcutta, India in 1863. He was inspired by his teacher, Ramakrishna to serve men as visible manifestations of God. In 1893 Swami Vivekananda began a tour of the west by attending the Parliament of Religions held in Chicago. During the three years that he toured the United States and Europe, Vivekananda met with many of the well known scientists of the time including Lord Kelvin and Nikola Tesla. [7] According to Swami Nikhilananda:

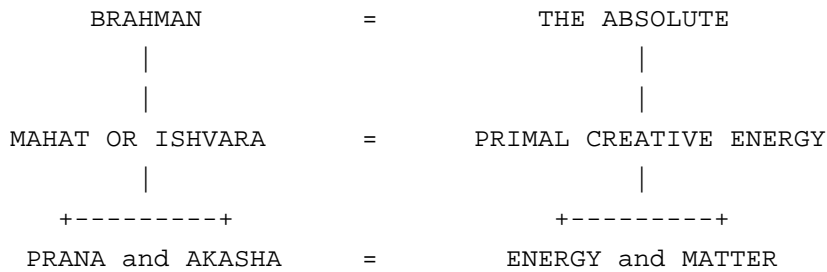
Nikola Tesla, the great scientist who specialized in the field of electricity, was much impressed to hear from the Swami his explanation of the Samkhya cosmogony and the theory of cycles given by the Hindus. He was particularly struck by the resemblance between the Samkhya theory of matter and energy and that of modern physics. The Swami also met in New York Sir William Thompson, afterwards Lord Kelvin, and Professor Helmholtz, two leading representatives of western science. Sarah Bernhardt, the famous French actress had an interview with the Swami and greatly admired his teachings. [8]

It was at a party given by Sarah Bernhardt that Nikola Tesla probably first met Swami Vivekananda. [9] Sarah Bernhardt was playing the part of 'Iziel' in a play of the same name. It was a French version about the life of Bhudda. The actress upon seeing Swami Vivekananda in the audience, arranged a meeting which was also attended by Nikola Tesla. In a letter to a friend, dated February 13th, 1896, Swami Vivekananda noted the following:

...Mr. Tesla was charmed to hear about the Vedantic Prana and Akasha and the Kalpas, which according to him are the only theories modern science can entertain....Mr Tesla thinks he can demonstrate that mathematically that force and matter are reducible to potential energy. I am to go see him next week to get this mathematical demonstration. [10]

Swami Vivekananda was hopeful that Tesla would be able to show that what we call matter is simply potential energy because that would reconcile the teachings of the Vedas with modern science. The Swami realized that "In that case, the Vedantic cosmology [would] be placed on the surest of

foundations". The harmony between Vedantic theories and western science was explained by the following diagram:



Tesla understood the Sanskrit terminology and philosophy and found that it was a good means to describe the physical mechanisms of the universe as seen through his eyes. It would behoove those who would attempt to understand the science behind the inventions of Nikola Tesla to study Sanskrit and Vedic philosophy.

Tesla apparently failed to show the identity of energy and matter. If he had, certainly Swami Vivekananda would have recorded that occasion. The mathematical proof of the principle did come until about ten years later when Albert Einstein published his paper on relativity. What had been known in the East for the last 5,000 years was then known to the West.

Brahman is defined as the one self-existent impersonal spirit; the Divine Essence, from which all things emanate, by which they are sustained, and to which they return. Notice that this is very similar to the concept of the Great Spirit as understood by Native American cultures. Ishvara is the Supreme Ruler; the highest possible conception of the Absolute, which is beyond all thought. Mahat means literally the Great One, and is also interpreted as meaning universal mind or cosmic intelligence. Prana means energy (usually translated as life force) and Akasha means matter (usually translated as ether). Dobson points out that the more common translations for Akasha and Prana are not quite correct, but that Tesla did understand their true meanings.

The meeting with Swami Vivekananda greatly stimulated Nikola Tesla's interest in Eastern Science. The Swami later remarked during a lecture in India, "I myself have been told by some of the best scientific minds of the day, how wonderfully rational the conclusions of the Vedanta are. I know of one of them personally, who scarcely has time to eat his meal, or go out of his laboratory, but who would stand by the hour to attend my lectures on the Vedanta; for, as he expresses it, they are so scientific, they so exactly harmonize with the aspirations of the age and with the conclusions to which modern science is coming at the present time". [11]

Tesla and Lord Kelvin

William S. Thompson was one of the prominent scientists and engineers of the 1800s. He developed analogies between heat and electricity and his work influenced the theories developed by James Clerk Maxwell, one of the founders of electromagnetic theory. Thompson supervised the successful laying of the Trans Atlantic Cable and for that work was knighted Lord Kelvin. Kelvin had endorsed Tesla's theories and proposed system for the wireless transmission of electrical power. [12] FootNOTE - Grotz PACE

Tesla continued to study Hindu and Vedic philosophy for a number of years as indicated by the following letter written to him by Lord Kelvin.

15, Eaton Place
London, S.W.
May 20, 1902

Dear Mr. Tesla,

I do not know how I can ever thank you enough for the most kind letter of May, 10, which I found in my cabin in the Lucania, with the beautiful books which you most kindly sent me along with it: -"The Buried Temple", "The Gospel of Bhudda", Les Grands Initiés", the exquisite edition of Rossetti's "House of Life", and last but not least the Century Magazine for June, 1900 with the splendid and marvelous photographs on pp. 176, 187, 190, 191, 192, full of electrical lessons.

We had a most beautiful passage across the Atlantic, much the finest I have ever had. I was trying hard nearly all the way, but quite unsuccessfully, to find something definite as to the functions of ether in respect to plain, old fashioned magnetism. A propos of this, I have instructed the publishers, Messrs. Macmillan, to send you at the Waldorf a copy of my book (Collection of Separate Papers) on Electrostatics and Magnetism. I shall be glad if you will accept it from me as a very small mark of my gratitude to you for your kindness. You may possibly find something interesting in the articles on Atmospheric Electricity which it contains.

Lady Kelvin joins me in kind regards, and I remain,

Yours always truly,

Kelvin

Thank you also warmly for the beautiful flowers [13]

Tesla and Russell

Walter Russell was one of the most accomplished artists, sculptors, writers and scientists of this century. His periodic chart of the elements accurately predicted the location and characteristics of four elements years before they were discovered in laboratories. These are now known as Deuterium, Tritium, Neptunium, and Plutonium. Russell apparently entered into a heightened state of awareness after being struck by lightning. He began several weeks of drawing and writing about the basic nature and make up of the physical universe. Russells' family finally called the family doctor to determine if Russell should be committed to an mental institution. The doctor, upon seeing the results of Russells weeks of work, said that he did not know what Russell was doing, but that he definitely was not mad.

Although the exact time and occasion of their meeting has not yet been determined, Nikola Tesla and Walter Russell did meet and discuss their respective cosmologies. 14 Tesla recognized the wisdom and power of Russells' teaching and urged Russell to lock up his knowledge in a safe for 1,000 years until man was ready for it. [15]

The Appearance of Free Energy - Or Why Free Energy has not yet Happened - Comments, Possibilities and Socio Economic Implications

Although Tesla did not accept many of the tenants of relativity and quantum theory and never made the connection between matter and energy, he did recognize the possibility of free and unlimited energy as demonstrated by the following statement.

Can Man control [the] grandest, most awe inspiring of all processes in nature?...If he could do this, he would have powers almost unlimited and supernatural... He could cause planes to collide and produce his suns and stars, his heat and light. He could originate and develop life in all its infinite forms....[Such powers] would place him beside his creator, make him fulfill his ultimate destiny. [16]

We see that Tesla is asking a question, speculating, searching for an answer. If Tesla had developed free energy sources or learned how to manipulate space time and gravity, during the time of his most public and productive years, (up until about 1920), he would have had answers to those questions.

Tesla's most misunderstood invention is popularly known as the "Death Ray". It was simply a particle beam weapon which he proposed in 1937 and was fabricated under contracts with Alcoa Aluminum and the English and Italian governments. [17] It used electrostatic propulsion techniques and similar devices are being developed today by the Strategic Defense Initiative Organization (SDIO) and the US Army Strategic Defense Command. [18]

So we see that mankind has not yet harnessed the infinite power of the universe as envisioned by Nikola Tesla. The question remains, why not?

Free energy devices, if they are feasible, are not about smaller faster microcircuits or a bigger better mouse traps. This is a technology which may revolutionize the socio-economic status quo on planet Earth. At this moment the big pie is unevenly divided. One quarter of the population on this rock, the third stone from the sun, consumes three quarters of the yearly resource output. As one can easily deduce, from a brief study of world affairs, there are about three billion people who have just about had it with this scenario. There are wars starvation and strife in every nook and cranny of the planet. So what do we do about it?

Spaceship Earth Needs A Flight Plan

Either we divide the pie more evenly or we make the pie larger. The first option requires that our standard of living must fall so that the standard of living in the third world may rise. The second option allows us to maintain our standard of living while we help raise the standard of living of under privileged nations. This we must do. It is our destiny. It is our responsibility. It is our final test.

Thirty thousand people starve to death every day on this planet, most of them are children. Nations fight nations, war is part of our lives. What drives our economy in the western world, allows us to enjoy a high standard of living, a life of leisure compared to our neighbors south of the imaginary line called a border? Many answers both economic, social, political, and spiritual can be given. We do know that the standard of living that a nation enjoys is directly related energy consumption.

Energy drives the economies of nations and Tesla's life long goal was to make electric power equally available to all people any where on this planet. He continued to promote his plan for the wireless transmission of power in the yearly interviews he gave on his birthday as late as 1940. [19] Electrical power allows on site processing of raw materials. Electrical power can run pumps from water wells in areas affected by drought. Electrical power delivered to the poverty stricken areas of the world can make the pie larger, can help bring about the needed economic equality which is our birth right.

Why hasn't power been made equally available to all people and nations? Why haven't the much touted free energy devices described by Tom Bearden, John Bedini, Bruce DePalma, and others ever materialized? Perhaps because "easy things are seldom done for the same reason that impossible things are rarely done: no one will pay for anything believed to be easy or impossible". [20] Perhaps because when we talk about power there is more there than one would initially visualize. What we are talking about is personal power, national power, planetary power, karmic power and the power of love.

The sages tell us that in order to enjoy power we have to let go of power, to overcome ourselves. As an example this author can describe one of his recent experiences. After a very successful symposium celebrating the 100th year after Nikola Tesla arrived in the United States 21, a non profit corporation, 501(c)(3), was formed specifically to encourage and pursue research into the inventions and discoveries of Nikola Tesla. Two years later, after a second symposium, several of the founding members approached the board of directors with a proposal to validate Tesla's claim that wireless transmission of power was possible. Board members suggested that permission be obtained from the FCC, an environmental impact statement be filed with the EPA, and we should go form "our own non profit corporation". It was also decided that since there was no procedure to cover research, the organization could not be involved.

Another goal of the organization had been to establish a museum to be named the Nikola Tesla Museum of Science and Technology. We proposed that since 60 -70 billion dollars are given away to non profit organizations annually, we had as good a chance as any other organization for obtaining funding, for a museum or research. We reasoned that:

"Since only 16% of the museums in this country are science museums, this museum in honor of Nikola Tesla will help educate the public in technological areas. With the need for economic revitalization of industry in Colorado, 1986 is the time to begin supporting the scientific education of our region. With the current statistics showing that the United States is falling behind the world technologically, the effort to educate the public is becoming more important, and the surge of public awareness of Nikola Tesla's inventions makes him an appropriate namesake for a science and technology museum." [23]

The board moved to table our proposal indefinitely.

What had happened? Of the 15 - 20 people that had started the organization only four remained as part of the governing body. Three of those members were opposed to research. The collective mind of the board of directors had become the antithesis of the momentum Tesla had gained in his lifetime. Unlike the independent inventor and businessman, the board was now

composed of members who were bureaucrats and paper pushers for Fortune 500 companies. Tesla was a vegetarian, the board members all ate meat. Tesla did not ask for permission to be inventive and strike out on bold new adventures, the board needed approval from higher sources. The dichotomies were endless.

Tesla's visions have been delayed for 89 years. The squabbling started with Thomas Edison, J.P. Morgan and Nikola Tesla himself. 24 It continues to this day. Perhaps the reason for the delay of wireless power transmission or free energy devices lies even deeper within the human psyche. Is it possible that we could compare the Tesla story to a biblical story? Bruce Gordan thinks so. In Gordan's analysis Tesla's attempt at building a prototype magnifying transmitter parallels Genesis 11:1-9. [25]

"The message; human curiosity and technological derring-do makes God nervous; God demolishes project, confounds language". Gordan further outlines the the scenario as follows:

"When everything is perfect, the right time shows up." [26] This is equivalent to saying, "Absolute knowledge in the hands of one whose heart is not yet tender, would be a terrible weapon. [27] We might postulate that technological developments do not occur until the planet is ready. The recent examination of the theory of Gaia credits the Earth with an intelligence. "Thousands of years ago, by means of seeing, sorcerers became aware that the Earth was sentient and that its awareness could affect the awareness of humans." [28] By implication of reciprocity the reverse could be true. The group or collective unconscious is still struggling with the result of quantum and relativity theory. We as a race were ready for nuclear power, every thing was perfect and the right time showed up. Soon we will have put the technology to good use or abandon it to insure our survival as a species.

So What Do You Do About It - Free Energy: Creating An Idea Whose Time Has Come

Wireless transmission of power and free energy have not happened yet, perhaps we aren't ready, perhaps the Earth isn't ready. Pogo said it best, " we have met the enemy and it is us." In the Jungian view of collective unconscious, things happen when the time is right, we get what we agree to. We need a flight plan. And that plan must realize that:

WHEN THE POWER OF LOVE OVERCOMES

THE LOVE OF POWER THERE WILL BE PEACE

[Source; Girls Lavatory, Boulder High School, Boulder, Colorado]

Described as "Post Industrial, neo-technical, teen-age graffiti."

"So astounding are the facts in this connection, that it would seem as though the Creator, himself had electrically designed this planet..."

Nikola Tesla describing what is now known as Schumann Resonance (7.8 Hz) in "The Transmission of Electrical Energy Without Wires As A Means Of Furthering World Peace", *Electrical World And Engineer*, January 7, 1905, PP 21-24.

Footnotes

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ETHER AND THE THEORY OF RELATIVITY

BY ALBERT EINSTEIN

AN ADDRESS DELIVERED ON MAY 5TH, 1920, IN THE
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How does it come about that alongside of the idea of ponderable matter, which is derived by abstraction from everyday life, the physicists set the idea of the existence of another kind of matter, the ether? The explanation is probably to be sought in those phenomena which have given rise to the theory of action at a distance, and in the properties of light which have led to the undulatory theory. Let us devote a little while to the consideration of these two subjects.

Outside of physics we know nothing of action at a distance. When we try to connect cause and effect in the experiences which natural objects afford us, it seems at first as if there were no other mutual actions than those of immediate contact, e.g. the communication of motion by impact, push and pull, heating or inducing combustion by means of a flame, etc. It is true that even in everyday experience weight, which is in a sense action at a distance, plays a very important part. But since in daily experience the weight of bodies meets us as something constant, something not linked to any cause which is variable in time or place, we do not in everyday life speculate as to the cause of gravity, and therefore do not become conscious of its character as action at a distance. It was Newton's theory of gravitation that first assigned a cause for gravity by interpreting it as action at a distance, proceeding from masses. Newton's theory is probably the greatest stride ever made in the effort towards the causal nexus of natural phenomena. And yet this theory evoked a lively sense of discomfort among Newton's contemporaries, because it seemed to be in conflict with the principle springing from the rest of experience, that there can be reciprocal action only through contact, and not through immediate action at a distance.

It is only with reluctance that man's desire for knowledge endures a dualism of this kind. How was unity to be preserved in his comprehension of the forces of nature? Either by trying to look upon contact forces as being themselves distant forces which admittedly are observable only at a very small distance and this was the road which Newton's followers, who were entirely under the spell of his doctrine, mostly preferred to take; or by assuming that the Newtonian action at a distance is only apparently immediate action at a

distance, but in truth is conveyed by a medium permeating space, whether by movements or by elastic deformation of this medium. Thus the endeavour toward a unified view of the nature of forces leads to the hypothesis of an ether. This hypothesis, to be sure, did not at first bring with it any advance in the theory of gravitation or in physics generally, so that it became customary to treat Newton's law of force as an axiom not further reducible. But the ether hypothesis was bound always to play some part in physical science, even if at first only a latent part.

When in the first half of the nineteenth century the far-reaching similarity was revealed which subsists between the properties of light and those of elastic waves in ponderable bodies, the ether hypothesis found fresh support. It appeared beyond question that light must be interpreted as a vibratory process in an elastic, inert medium filling up universal space. It also seemed to be a necessary consequence of the fact that light is capable of polarisation that this medium, the ether, must be of the nature of a solid body, because transverse waves are not possible in a fluid, but only in a solid. Thus the physicists were bound to arrive at the theory of the "quasi-rigid" luminiferous ether, the parts of which can carry out no movements relatively to one another except the small movements of deformation which correspond to light-waves.

This theory also called the theory of the stationary luminiferous ether moreover found a strong support in an experiment which is also of fundamental importance in the special theory of relativity, the experiment of Fizeau, from which one was obliged to infer that the luminiferous ether does not take part in the movements of bodies. The phenomenon of aberration also favoured the theory of the quasi-rigid ether.

The development of the theory of electricity along the path opened up by Maxwell and Lorentz gave the development of our ideas concerning the ether quite a peculiar and unexpected turn. For Maxwell himself the ether indeed still had properties which were purely mechanical, although of a much more complicated kind than the mechanical properties of tangible solid bodies. But neither Maxwell nor his followers succeeded in elaborating a mechanical model for the ether which might furnish a satisfactory mechanical interpretation of Maxwell's laws of the electro-magnetic field. The laws were clear and simple, the mechanical interpretations clumsy and contradictory. Almost imperceptibly the theoretical physicists adapted themselves to a situation which, from the standpoint of their mechanical programme, was very depressing. They were particularly influenced by the electro-dynamical investigations of Heinrich Hertz. For whereas they previously had required of a conclusive theory that it should content itself with the fundamental concepts which belong exclusively to mechanics (e.g. densities, velocities, deformations, stresses) they gradually accustomed themselves to admitting electric and magnetic force as fundamental concepts side by side with those of

mechanics, without requiring a mechanical interpretation for them. Thus the purely mechanical view of nature was gradually abandoned. But this change led to a fundamental dualism which in the long-run was insupportable. A way of escape was now sought in the reverse direction, by reducing the principles of mechanics to those of electricity, and this especially as confidence in the strict validity of the equations of Newton's mechanics was shaken by the experiments with b-rays and rapid kathode rays.

This dualism still confronts us in unextenuated form in the theory of Hertz, where matter appears not only as the bearer of velocities, kinetic energy, and mechanical pressures, but also as the bearer of electromagnetic fields. Since such fields also occur in vacuo i.e. in free ether the ether also appears as bearer of electromagnetic fields. The ether appears indistinguishable in its functions from ordinary matter. Within matter it takes part in the motion of matter and in empty space it has everywhere a velocity; so that the ether has a definitely assigned velocity throughout the whole of space. There is no fundamental difference between Hertz's ether and ponderable matter (which in part subsists in the ether).

The Hertz theory suffered not only from the defect of ascribing to matter and ether, on the one hand mechanical states, and on the other hand electrical states, which do not stand in any conceivable relation to each other; it was also at variance with the result of Fizeau's important experiment on the velocity of the propagation of light in moving fluids, and with other established experimental results.

Such was the state of things when H. A. Lorentz entered upon the scene. He brought theory into harmony with experience by means of a wonderful simplification of theoretical principles. He achieved this, the most important advance in the theory of electricity since Maxwell, by taking from ether its mechanical, and from matter its electromagnetic qualities. As in empty space, so too in the interior of material bodies, the ether, and not matter viewed atomistically, was exclusively the seat of electromagnetic fields. According to Lorentz the elementary particles of matter alone are capable of carrying out movements; their electromagnetic activity is entirely confined to the carrying of electric charges. Thus Lorentz succeeded in reducing all electromagnetic happenings to Maxwell's equations for free space.

As to the mechanical nature of the Lorentzian ether, it may be said of it, in a somewhat playful spirit, that immobility is the only mechanical property of which it has not been deprived by H. A. Lorentz. It may be added that the whole change in the conception of the ether which the special theory of relativity brought about, consisted in taking away from the ether its last mechanical quality, namely, its immobility. How this is to be understood will forthwith be expounded.

The space-time theory and the kinematics of the special theory of relativity were modelled on the Maxwell-Lorentz theory of the electromagnetic field. This theory therefore satisfies the conditions of the special theory of relativity, but when viewed from the latter it acquires a novel aspect. For if K be a system of co-ordinates relatively to which the Lorentzian ether is at rest, the Maxwell-Lorentz equations are valid primarily with reference to K . But by the special theory of relativity the same equations without any change of meaning also hold in relation to any new system of co-ordinates K' which is moving in uniform translation relatively to K . Now comes the anxious question: Why must I in the theory distinguish the K system above all K' systems, which are physically equivalent to it in all respects, by assuming that the ether is at rest relatively to the K system? For the theoretician such an asymmetry in the theoretical structure, with no corresponding asymmetry in the system of experience, is intolerable. If we assume the ether to be at rest relatively to K , but in motion relatively to K' , the physical equivalence of K and K' seems to me from the logical standpoint, not indeed downright incorrect, but nevertheless unacceptable.

The next position which it was possible to take up in face of this state of things appeared to be the following. The ether does not exist at all. The electromagnetic fields are not states of a medium, and are not bound down to any bearer, but they are independent realities which are not reducible to anything else, exactly like the atoms of ponderable matter. This conception suggests itself the more readily as, according to Lorentz's theory, electromagnetic radiation, like ponderable matter, brings impulse and energy with it, and as, according to the special theory of relativity, both matter and radiation are but special forms of distributed energy, ponderable mass losing its isolation and appearing as a special form of energy.

More careful reflection teaches us, however, that the special theory of relativity does not compel us to deny ether. We may assume the existence of an ether,; only we must give up ascribing a definite state of motion to it, i.e. we must by abstraction take from it the last mechanical characteristic which Lorentz had still left it. We shall see later that this point of view, the conceivability of which shall at once endeavour to make more intelligible by a somewhat halting comparison, is justified by the results of the general theory of relativity.

Think of waves on the surface of water. Here we can describe two entirely different things. Either we may observe how the undulatory surface forming the boundary between water and air alters in the course of time; or else with the help of small floats, for instance we can observe how the position of the separate particles of water alters in the course of time. If the existence of such floats for tracking the motion of the particles of a fluid were a fundamental impossibility in physics if, in fact, nothing else whatever were observable than the shape of the space occupied by the water as it varies in time, we should

have no ground for the assumption that water consists of immovable particles. But all the same we could characterize it as a medium.

We have something like this in the electromagnetic field. For we may picture the field to ourselves as consisting of lines of force. If we wish to interpret these lines of force to ourselves as something immaterial in the ordinary sense, we are tempted to interpret the dynamic processes as motions of these lines of force, such that each separate line of force is tracked through the course of time. It is well known, however, that this way of regarding the electromagnetic field leads to contradictions.

Generalizing we must say this: There may be supposed to be extended physical objects to which the idea of motion cannot be applied. They may not be thought of as consisting of particles which allow themselves to be separately tracked through time. In Minkowski's idiom this is expressed as follows: Not every extended conformation in the four-dimensional world can be regarded as composed of worldthreads. The special theory of relativity forbids us to assume the ether to consist of particles observable through time, but the hypothesis of ether in itself is in conflict with the special theory of relativity. Only we must be on our guard against ascribing a state of motion to the ether.

Certainly, from the standpoint of the special theory of relativity, the ether hypothesis appears at first to be an empty hypothesis. In the equations of the electromagnetic field there occur, in addition to the densities of the electric charge, only the intensities of the field. The career of electromagnetic processes in vacuum appears to be completely determined by these equations, uninfluenced by other physical quantities. The electromagnetic fields appear as ultimate, irreducible realities, and at first it seems superfluous to postulate a homogeneous, isotropic ether-medium, and to envisage electromagnetic fields as states of this medium.

But on the other hand there is a weighty argument to be adduced in favour of the ether hypothesis. To deny the ether is ultimately to assume that empty space has no physical qualities whatever. The fundamental facts of mechanics do not harmonize with this view. For the mechanical behaviour of a corporeal system hovering freely in empty space depends not only on relative positions (distances) and relative velocities, but also on its state of rotation, which physically may be taken as a characteristic not appertaining to the system in itself. In order to be able to look upon the rotation of the system, at least formally, as something real, Newton objectivises space. Since he classes his absolute space together with real things, for him rotation relative to an absolute space is also something real. Newton might no less well have called his absolute space "Ether"; what is essential is merely that besides observable objects, another thing, which is not perceptible, must be looked upon as real, to enable acceleration or rotation to be looked upon as something real.

It is true that Mach tried to avoid having to accept as real something which is not observable by endeavouring to substitute in mechanics a mean acceleration with reference to the totality of the masses in the universe in place of an acceleration with reference to absolute space. But inertial resistance opposed to relative acceleration of distant masses presupposes action at a distance; and as the modern physicist does not believe that he may accept this action at a distance, he comes back once more, if he follows Mach, to the ether, which has to serve as medium for the effects of inertia. But this conception of the ether to which we are led by Mach's way of thinking differs essentially from the ether as conceived by Newton, by Fresnel, and by Lorentz. Mach's ether not only conditions the behaviour of inert masses, but is also conditioned in its state by them.

Mach's idea finds its full development in the ether of the general theory of relativity. According to this theory the metrical qualities of the continuum of space-time differ in the environment of different points of space-time, and are partly conditioned by the matter existing outside of the territory under consideration. This space-time variability of the reciprocal relations of the standards of space and time, or, perhaps, the recognition of the fact that "empty space" in its physical relation is neither homogeneous nor isotropic, compelling us to describe its state by ten functions (the gravitation potentials g), has, I think, finally disposed of the view that space is physically empty. But therewith the conception of the ether has again acquired an intelligible content, although this content differs widely from that of the ether of the mechanical undulatory theory of light. The ether of the general theory of relativity is a medium which is itself devoid of all mechanical and kinematical qualities, but helps to determine mechanical (and electromagnetic) events.

What is fundamentally new in the ether of the general theory of relativity as opposed to the ether of Lorentz consists in this, that the state of the former is at every place determined by connections with the matter and the state of the ether in neighbouring places, which are amenable to law in the form of differential equations; whereas the state of the Lorentzian ether in the absence of electromagnetic fields is conditioned by nothing outside itself, and is everywhere the same. The ether of the general theory of relativity is transmuted conceptually into the ether of Lorentz if we substitute constants for the functions of space which describe the former, disregarding the causes which condition its state. Thus we may also say, I think, that the ether of the general theory of relativity is the outcome of the Lorentzian ether, through relativation.

As to the part which the new ether is to play in the physics of the future we are not yet clear. We know that it determines the metrical relations in the space-time continuum, e.g. the configurative possibilities of solid bodies as well as the gravitational fields; but we do not know whether it has an essential share in the structure of the electrical elementary particles constituting matter.

Nor do we know whether it is only in the proximity of ponderable masses that its structure differs essentially from that of the Lorentzian ether; whether the geometry of spaces of cosmic extent is approximately Euclidean. But we can assert by reason of the relativistic equations of gravitation that there must be a departure from Euclidean relations, with spaces of cosmic order of magnitude, if there exists a positive mean density, no matter how small, of the matter in the universe. In this case the universe must of necessity be spatially unbounded and of finite magnitude, its magnitude being determined by the value of that mean density.

If we consider the gravitational field and the electromagnetic field from the standpoint of the ether hypothesis, we find a remarkable difference between the two. There can be no space nor any part of space without gravitational potentials; for these confer upon space its metrical qualities, without which it cannot be imagined at all. The existence of the gravitational field is inseparably bound up with the existence of space. On the other hand a part of space may very well be imagined without an electromagnetic field; thus in contrast with the gravitational field, the electromagnetic field seems to be only secondarily linked to the ether, the formal nature of the electromagnetic field being as yet in no way determined by that of gravitational ether. From the present state of theory it looks as if the electromagnetic field, as opposed to the gravitational field, rests upon an entirely new formal motif, as though nature might just as well have endowed the gravitational ether with fields of quite another type, for example, with fields of a scalar potential, instead of fields of the electromagnetic type.

Since according to our present conceptions the elementary particles of matter are also, in their essence, nothing else than condensations of the electromagnetic field, our present view of the universe presents two realities which are completely separated from each other conceptually, although connected causally, namely, gravitational ether and electromagnetic field, or as they might also be called space and matter.

Of course it would be a great advance if we could succeed in comprehending the gravitational field and the electromagnetic field together as one unified conformation. Then for the first time the epoch of theoretical physics founded by Faraday and Maxwell would reach a satisfactory conclusion. The contrast between ether and matter would fade away, and, through the general theory of relativity, the whole of physics would become a complete system of thought, like geometry, kinematics, and the theory of gravitation. An exceedingly ingenious attempt in this direction has been made by the mathematician H. Weyl; but I do not believe that his theory will hold its ground in relation to reality. Further, in contemplating the immediate future of theoretical physics we ought not unconditionally to reject the possibility that the

facts comprised in the quantum theory may set bounds to the field theory beyond which it cannot pass.

Recapitulating, we may say that according to the general theory of relativity space is endowed with physical qualities; in this sense, therefore, there exists an ether. According to the general theory of relativity space without ether is unthinkable; for in such space there not only would be no propagation of light, but also no possibility of existence for standards of space and time (measuring-rods and clocks), nor therefore any space-time intervals in the physical sense. But this ether may not be thought of as endowed with the quality characteristic of ponderable media, as consisting of parts which may be tracked through time. The idea of motion may not be applied to it.

AETHER, RELATIVITY AND SUPERFLUIDITY

BY BARRY C. MINGST

Abstract

A review of the basics of special and general relativity. The basis of both special relativity and general relativity is superfluid equations -- Maxwell's equations for special relativity and generalized superfluid equations for general relativity. Demonstration that a superfluid aether results in both special and general relativity as special cases. Resolution of the Feynman arguments against an aether as a gravitational source. Discussion of the Thirring-Lenz experiment tending to confirm physical aether medium versus "mathematical" or "continuum" cause of gravity.

Introduction

"According to the general theory of relativity space is endowed with physical qualities; in this sense, therefore, there exists an aether. According to the general theory of relativity space without aether is unthinkable."

A. Einstein, Sidelights on Relativity, 1922, page 23.

This paper examines one possible physically causative agent for gravitation of matter bodies. This causative agent is a superfluid aether. This aether is not matter, but matter is affected by the aether. Superfluidity is the basis for Maxwell's equations, special relativity, and general relativity.

The concept of the aether arose from the study of the behavior of wave action and light. Even before the kinetic theory of gases provided microscopic concepts, the study of the sensible world allowed a fairly consistent view of wave action. Light was clearly identified in the wave category of phenomena. The debate as to what the ultimate underlying nature of light was (wave or particulate) spanned several centuries of theory and experiment. Not until the twentieth century was it ever contended that "waves" of light did not have an underlying physical medium.

The main objection to fluid aether theories came from light's propagation as transverse waves. Up to the time of the general abandonment of deterministic (classical) physics at the microscopic level (with the rise of quantum physics in the 1920's) no "reasonable" way to explain this behavior of light was generally accepted. "The" aether theory being tested by the famous Michaelson-Morely experiment was the "solid" aether theory that was in

ascendence at the time. This theory assumed that the aether was physically separate from matter -- that is, they were not related.

The demise of the concept of the aether resulted from the tumultuous evolution of the physical concepts of the early twentieth century (quantum theory and general relativity). Quantum mechanicians developed the concepts of "probability density" and non-causality. General relativists picked up on the shorthand of space-time developed by Minkowski in 1908 for special relativity and expanded it to a mathematical "space-time continuum." Although most specifically denied a physical medium, Einstein clearly realized that both special and general relativity were based on fluid dynamical models {Handbook of Physics, Condon and Odishaw, Page 2-50, Section 29}.

The Derivation of Maxwell's Equations

One of the most successful theoretical works in physics is Maxwell's theory of electricity and magnetism. Maxwell's equations united and mathematically quantified the interaction of electrical and magnetic effects. In deriving these equations, Maxwell made certain assumptions about the nature of the medium that carried electricity, magnetism, and light. The primary assumption used by Maxwell was that the underlying medium could be described using the perfect fluid vortex theory developed by Helmholtz.

"The consideration of the action of magnetism on polarized light leads, as we have seen, to the conclusion that in a medium under the action of magnetic force is something belonging to the same mathematical class as an angular velocity, whose axis is in the direction of the magnetic force, forms a part of the phenomenon.

"This angular velocity cannot be that of any portion of the medium of sensible dimensions rotating as a whole. We must therefore conceive the rotation to be that of very small portions of the medium, each rotating on its own axis. This is the hypothesis of molecular vortices.

"The motion of these vortices, though, as we have shewn ..., does not sensibly affect the visible motions of large bodies, may be such as to affect that vibratory motion on which the propagation of light, according to the undulatory theory, depends. The displacements of the medium, during the propagation of light, will produce a disturbance of the vortices, and the vortices when so disturbed may react on the medium so as to affect the mode of propagation of the ray."...

"... We shall therefore assume that the variation of vortices caused by the displacement of the medium is subject to the same conditions which Helmholtz, in his great memoir on Vortex-motion, has shewn to regulate the variation of the vortices of a perfect fluid."

J. Maxwell, A Treatise on Electricity and Magnetism, 1873, sections 822 and 823.

There have been attempts in the past to "expand" Maxwell's equations in the name of symmetry. One of these was the concept of magnetic monopoles. It was determined that magnetic monopoles could be inserted into Maxwell's equations and the equations would remain self-consistent and usable. The hunt for magnetic monopoles in the 1970's ended without any confirmed monopoles. Another attempt was the expansion of Maxwell's equations to include positive and negative charges as "carriers" of the weak nuclear force. This is what is now known as the "electroweak" force. This expansion of Maxwell's equations is also self-consistent and usable. In this case particles of mass roughly in the range expected have been found.

What is missing from these expansions is any physical concept that would give rise to these expansions. It must be stressed that Maxwell derived his equations. He did not just write them down and then note that they happened to work. The derivation was the direct result of the physical postulates (superfluid aether and vortices) he made in his derivation. Magnetic monopoles and "weak" nuclear theory do not arise from Maxwell's equations. There is therefore no physical basis for expecting these equations to work.

The Derivation of Special Relativity

The special theory of relativity was derived from Maxwell's Equations. The Special Theory was a leap of quantification based on an apparent anomaly. Maxwell's equations imply that the measured speed of light (in a vacuum) is constant for any observer -- regardless of how that observer was moving relative to the source of light.

In developing Special Relativity, Einstein postulated the universality of the speed of light and applied the mathematical consequences to see where they would lead. The primary result of the special theory of relativity was the equivalence of matter and energy ($E=mc^2$). The Lorentz-Fitzgerald relations had been developed earlier from standard aether wave theories (which is why they are called Lorentz-Fitzgerald equations instead of Einstein equations). Special Relativity is therefore based on the superfluid derivations of Maxwell and Hemholtz.

Minkowski Space-Time

The concept of "space-time" was first developed by Minkowski in 1908 for use with the Special Theory of Relativity. In this first incarnation, Minkowski pointed out that the mathematical equations may be written in a shorthand form by regarding time and the three physical coordinates as four coordinates in a four-dimensional space, called "space-time."

In an inertial, cartesian reference frame a pulse of light emitted at time $t=t_0$ and location $x = x_0$, $y = y_0$, and $z = z_0$ will be noted at a point x , y , z , t given by the equation {eq 4.2 An Introduction to Tensor Calculus, Relativity and Cosmology, D Lawden, 1975, Wiley and Sons}:

This equation describes an expanding spherical shell for the light pulse. A shorthand version of this equation was developed by Minkowski by the use of the mathematical device of setting:

$$x = x_1, y = x_2, z = x_3, \text{ and } ict = x_4; \text{ where } i = \text{SqrRoot}(-1)$$

The standard Minkowski space-time is given as {eq. 4.5, An Introduction to Tensor Calculus, Relativity and Cosmology, D Lawden, 1975, Wiley and Sons}:

General Relativity

Einstein's "field" equations may be written in the tensor form:

In this form, $G_{\alpha\beta}$ is the "Einstein Tensor", Λ is the "cosmological constant" (usually set to zero), g is the "metric" tensor, k is a constant set to 8π , and $T_{\alpha\beta}$ is the "stress-energy tensor." This form is actually shorthand notation for ten coupled differential equations {Equation 8.7, A first course in general relativity, Schutz, Cambridge University Press, 1990}. The value of 8π is obtained by demanding that Einstein's equations predict the correct behavior of planets in the solar system -- the Newtonian Limit (ibid, p199).

The claim is currently made that the mathematics of General Relativity requires the curvature of space. The question "How?" is answered with "It just does." The question of why the object travels the shortest path in curved space is also not addressed. General Relativity can give no answer because these are the basic postulates of the theory.

The differences in the concepts between General Relativity and Newtonian gravity are:

Newtonian: Mass (somehow) causes a gravitational force which causes true acceleration.

Einsteinian: Mass (somehow) causes a warping of space which results in apparent acceleration.

But the description of causation as a curvature of space is not sufficient to encompass what else General Relativity includes. If spacial curvature were all there were to General Relativity, there would be no difference in calculations between General Relativity and Newtonian gravity. General Relativity also imposes superfluid equations onto gravitational relationships. The imposition of superfluid equations has a very significant effect: the speed of propagation of gravity is thereby made finite. The finite transmission speed (and related

superfluid properties) is the significant difference between Newtonian gravity and General Relativity.

General Relativity is a relativistic theory of gravity. The first postulate of General Relativity is that the source of the gravitational field is the stress-energy tensor of a perfect fluid, T {sections 4.6 & 4.7, A first course in general relativity, Schutz}. This "stress-energy tensor" contains four non-zero components. These four components are the density of the perfect fluid and the pressure of the perfect fluid in each of the three physical axes. A perfect fluid in general relativity is defined as a fluid that has no viscosity and no heat conduction. It is a generalization of the "ideal gas" of ordinary thermodynamics.

Newtonian gravity is regarded as the result of a force. General Relativity distinguishes gravity from all other forces because "all bodies given the same initial velocity follow the same trajectory in a gravitational field, regardless of their internal composition" {ibid, p121}. Specifically, attempting to define a primal reference frame is considered "vacuous, since no free particle could possibly be a physical 'marker' for it" {ibid, p122}. This second postulate became the Equivalence Principle: Uniform gravitational fields are equivalent to frames that accelerate uniformly relative to inertial frames.

Although it is often stated that General Relativity shows that mass curves space, what GR actually states is that a curved spacetime represents the effects of gravity. The distinction is critical. All GR really requires is that free particles (and photons) act as if space were curved in some manner. All this means is that their trajectories curve in the presence of a massive object {ibid, p125}.

The same argument could be made for Coriolis forces. If we examine the coriolis forces that affect trajectories of moving objects over the surface of a rotating planet, we could reach the same results by postulating that Latitude "curves" space. The results of our calculations would be identical to those based on the physical cause. But we would not gain any knowledge of the cause, because we would not be looking for one.

In the direct application of its basic postulate, General Relativity suffers from the same basic weakness as the Newtonian quantification of gravity. No basis is given in General Relativity for how mass "curves" space, why masses follow the "shortest" path through curved space, or why the principle of equivalence exists. This is "action at a distance" reformulated. Einstein himself noted this weakness in that matter had to be added in to the equations "by hand" {The Reluctant Father of Black Holes, Scientific American, June 1996, p83}.

Thirring Lenz Experiment

General Relativity has some weaknesses in explaining accelerations seen in the vicinity of massive, rapidly spinning objects. In this situation, the Einsteinian/Newtonian quantification predicts no effects on first principles. But the Einsteinian formula solutions "require" a non-zero tangential velocity to be imparted by a spinning mass.

First principles of a space-time continuum cannot explain accelerations in the vicinity of rapidly rotating massive objects because the "warp" of space-time does not change with the rotation of the object. It has been explained that "inertial dragging" takes place. The explanation of inertial dragging (reference frame dragging) is a description without identification of a cause that can be traced to the base theory {pp 6 & 18-20, Rotating Fields in General Relativity, J. Islam, 1985}. According to this reference "(t)he precise connection in all its details has not yet been worked out."

But such a "drag" implies that there is a friction in the motion of mass with respect to the space-time continuum itself. Friction due to motion with respect to the continuum requires that the continuum be a fixed, primal reference frame -- which must be denied due to the basic assumption of relativity, that there can be no primal reference frame. General relativistic formulations show the requirement of tangential motion when the assumption is made that the continuum is a superfluid.

Resolution of Some Arguments Against

Aether Cause of Gravity

LeSage first discussed the possible "shadowing" of "ultra-mundane particles" as a cause of gravity in 1784. This approach has been abandoned several times by different people. According to Feynman, LeSage-type theories fail as follows:

"This particular idea has the following trouble: the earth, in moving around the sun, would impinge on more particles which are coming from its forward side than from its hind side Therefore there would be more impulse given the earth from the front, and the earth would feel a resistance to motion and would be slowing up in its orbit. One can calculate how long it would take for the earth to stop as a result of this resistance, and it would not take long enough for the earth to still be in its orbit, so this mechanism does not work. No machinery has ever been invented that 'explains' gravity without also predicting some other phenomenon that does not exist."

R. Feynman, Lectures on Physics, 1963, volume 1, chapter 7, pp 9-10

Performing a calculation of the type above leads to a "drag" on the order of 10-13 m/sec² for the earth in orbit {Dr. Steve Carlip, private communication to Paul Stowe}. A continuous acceleration on this order would stop the earth in around a million years.

But there is an unstated assumption in Feynman's argument that the "aether particles" are not circulating with the Earth's orbital motion. This is an excellent first assumption, but is it true? The presumption of particles circulating at the same orbital speed of the Earth appears at first to be only an excuse for "saving the theory."

However, we saw above that the mathematics of General Relativity and the observed Thirring-Lenz effect requires that there be some rotational motion in the vicinity of a rotating body. According to the primary assumptions of General Relativity, the Thirring-Lenz effect has no "basis." A superfluid aether would cause accelerations as a result of imparting a vortex spin on the aether field which would then accelerate the target body.

The sun is rotating rapidly in the direction of planetary (earth) orbits. According to General Relativity, the only solution that is not possible in such a situation is irrotational motion in the aether corpuscles. The key assumption in the argument that the earth "would impinge on more particles which are coming from its forward side than from its hind side" is based on non-circulating particles. According to General Relativity, this assumption is found to be invalid! Also, if the aether fluid is indeed a superfluid, once a rotation of the fluid is started it will continue without loss of energy.

The Feynman argument against the LeSage-type hypothesis was completely plausible, for there is no obvious reason to expect that the aether would be rotating along with the earth. But field rotation is both observed and a mathematical requirement of the superfluid vorticity in General Relativity. So, for the moment at least, our theory remains consistent with General Relativity.

This is not the only possible explanation for the earth not spiralling into the sun. The Feynman argument rests on the additional assumption that gravity (and the aether drag) is the only force acting on the earth's orbital motion. But -- in order to contract from a protostar -- the sun must have somehow lost most of its angular momentum to the planets. If this mechanism were the result of the rotating solar magnetic field, the solar field will interact with the magnetosphere of the earth (and the plasma within it). This interaction will lead to a transfer of angular momentum from the sun to the earth. In short -- all possible sources of orbital impulse must be examined before we throw out a superfluid aether.

The basis for Feynman's argument was the same as one made for the irrotational earth (geocentric cosmos), and dealt with by Galileo in his Dialog on Two World Systems in 1632. The argument went as follows:

According to (Claudius Ptolemy and Tycho Brahe), if the earth were moving (rotating) an object thrown vertically upward would not descend along the same line ..., the point on the earth under the object would have shifted while the object was in the air. Furthermore, if the earth were moving (rotating) from west to east, the direction required to explain the appearance of the heavens, then ... (p)eople on the earth would perpetually feel an east wind, just as a rider feels a wind in his face as he travels along. ...

Galileo had refuted the arguments ... in his Dialogue Concerning the Two Chief World Systems. Objects ... belong to the moving system of the earth, and as parts they participate in the motion of the whole in addition to their own observable motions."

Radner and Radner, Science and Unreason, Wadworth Publishing Company, 1982, p34

As the air moves with a rotating earth, so the aether moves with the orbiting earth. They are part of the same "world system." It is only because the aether is so much less noticeable than the air (to us) that we accept Feynman's argument without close examination. By General Relativity and the Thirring-Lenz effect, the aether MUST move around the rotating sun and the orbiting earth. A Feynman-type argument can only be used if it is demonstrated beyond any doubt that the two components are not part of the same "world system." Whenever one component is affected by the other they must be part of the same, coupled, world system -- and the interdependence cannot be dismissed without serious thought. In this case the wind affects the surface of the earth or the aether is presumed to affect the earth's orbit.

Even if the Thirring-Lenz effect has no bearing, there is also the gravitational "sling" argument. If gravity is the result of a superfluid aether, then the speed of propagation of gravity must be finite. If the speed of gravity is finite, then orbiting masses will accelerate out of orbit. This is supposedly due to the "lead" of the gravitational force, due to the past position of the second object. This is one "push" that could overcome or balance the "drag" of the aether. Proponents of GR state that it is only the "delicate balance" of GR that keeps the orbits from accelerating or decelerating.

Summary

Maxwell's equations were explicitly developed as fluid dynamical models, and require an underlying physical medium. Special relativity was derived from Maxwell's equations. General relativity is based on perfect fluid equations.

Thus, any theory based on one of these three theories implicitly retains all fluid dynamical properties. Any denial of an underlying physical medium by such a theorist is therefore hollow -- and merely shows ignorance on the part of

the practitioner concerning the history and derivation of the equations that are being used.

"Fundamental challenges to disciplines tend to come from outside. It is customary for students to be introduced to their fields of study gradually, as slowly unfolding mysteries, so that by the time they can see their subject as a whole, they have been so thoroughly imbued with conventional preconceptions and patterns of thought that they are extremely unlikely to be able to question its basic premises."

Martin Bernal *Black Athena: The Afroasiatic Roots of Classical Civilization*, Vol. I, 1987

A LOOK AT SCALAR TECHNOLOGY AND ONE OF ITS APPLICATIONS

BY WARREN YORK

EXTRAORDINARY SCIENCE, VOL. 2, NO. 1, 1990

3d Time & Space

For simplicity and concept of understanding I will be describing what we have come to know as the real world or what we perceive as being a three dimensional time and space on a linear plane.

The three dimensions being length, height and width. It really is a four dimensional space of which time being a man made factor for reference is the fourth dimension.

In reality space time is curved. If we zero in close enough we can talk about it as if it were linear if for nothing other than simplicity and understanding. If I were to try and talk about time and space as it really is then it would become complex dealing with arcs, spherical dimensions and higher mathematics as Kerr metrics. For now we will consider our dimension as a three dimensional time cube.

Hyperspace

In Fig. 1 we have our 3D Space/Time Cube. Our X axis will represent the axis of acceleration. The Z axis is our matter or object axis.

As our object target we will use a rectangular box having known length, height and width. [See Fig.5] It is not important to assign values to these figures as of yet. The pictorial concept is the important value of what I have to say about time and space.

We will let the Y axis represent Lambda or Light. It is light itself and not necessarily the speed of light. This would mean that light is 90 degrees in our 3D Space/Time Cube to matter. If we shifted reference points by rotation this would make our Z axis or matter axis now light and our Y axis which was our Light axis now matter. This is important for this is where Planks constant comes in. This makes Planks constant as important in our 3D Space/Time Cube as the speed of light is in the formula $E=MC^2$, E being energy, M the mass and C the speed of light.

You should now have a clear picture or viewpoint in your mind of the 3 dimensional rectangular box resting in our 3D Space/Time Cube in reference to our linear X,Y and X axis or perceivable world.

The fourth dimension being acceleration or the change in time one, delta one start reference point and time two or delta two the last reference point which will also give us the distance traveled between delta one and delta two. Now in Fig.5 look at the leading edge of our box which is parallel with the Y axis or light axis Lambda.

Now this leading edge is our reference point when we start talking about delta one to delta two or acceleration to the speed of light. Yes we cannot accelerate matter to the speed of light due to friction, but for all purposes we don't know that yet.

Let's just say we can for now and friction and other factors do not have an effect on our box. This friction and other factors is what Chuck Yeager thought he found at Mach one as the demon. Well the demon is there but way above Mach one and way below the speed of light. The demon is friction and resistance factors of which we don't need to worry about in our pictorial view. [See Fig.4 & 5] Now let's say we just found some super fuel called Element 115 for now. This is an inside pun, but it will do for those of you who need a physical means to drive our box to and beyond the speed of light.

We now set our box the Z axis in motion along the direction to the right on the X axis or acceleration plane. As we accelerate to the speed of light we will start to bend Space/Time itself. This means our Z axis will start to swing up toward our Y axis as we approach the speed of light. [See Fig. 5, A, B & C] Notice if we redraw our box in reference to our grid the box will seem to elongate as space/time is bent. This is what Einstein was talking about in relativity with the Lorentz Transformation.

Keep in mind at this point we are not moving along with the new box but looking at it from its original starting point. If we were to move with the box we would see no change in the space warp as to the box itself. In other words the box would not seem to elongate from within its own reference point but only from the original observers viewpoint.

Now in our three dimensional space/time there is one thing that we perceive in only two dimensions and that is a shadow of which light is a contributing factor. Now from our original reference point when we reach the speed of light the box would be perceived as a beam of light and the matter axis would have been warped or bent back on itself and from our original observer point would no longer be in our 3D space.

At that point if we continue to accelerate with our super fuel Element 115 to two times the speed of light we are now swapping our X axis for the Y axis since we have flipped 90 degrees and the box is in its new dimension.

When the box once again reaches another C in acceleration from delta one we would once again see the box but it would be 180 degrees out from our old 3 dimensional point. After it reaches three C and goes on to 4 C then you can kiss it goodbye for all practical purposes.

How long before we ever reached one C we found that demon that Yeager was looking for. Now friction and the other resistive factors [The Demon] tell us Mother Nature will never allow us to approach the problem of acceleration to the speed of light by sheer brute force alone. How sad, for I think we were on to something if it just wasn't for this Demon.

Wait! there is still hope. Let's fool Mother nature. Is there another way to bend Space/Time itself? Mother nature does it every day herself.

Before we can go on we must stop and look at just what is Space/Time itself. It's been called the Aether among other things. Let's just look at it as Jello or flexible rubber that is relative to us. It can and is detected but misunderstood as electromagnetic fields.

RF radiation or wave propagation through this space time are constructed with electromagnetic fields but in such a manner that they cause propagation in space time where electromagnetic fields alone only stress, twist and distort space time.

When the fields are removed by cutting off electron flow in a conductor [coil] the space time snaps back to the form before the distortion. This brings us to just what is this space time we have been talking about?

The Aether

This flexible rubber, Jello or what ever you wish to call it is Space Time itself or what Space Time is made up of. It has been called the Aether in the past so we shall also call it the Aether.

Now I know there has been debates on the existence of an Aether or not for many years. The last acceptance was that it did not exist. For those of you who wish to research into this aspect may wish to review the Silvertooth experiment. "

Abstract #1: Michelson-Morley type experiments are shown to be non-sequiturs because their logic fails to take into account the relationship between wavelength and propagation velocity. An experimental demonstration of anisotropy in wavelength is described." [1] "

Abstract #2: After a lapse of 100 years the Silvertooth experiment has achieved Michelson's objective and detected the Earth's motion through space by optical interference. The consequences of this new experiment will have a traumatic effect on physics. A related issue is the question of

reinterpreting the null result of the Trouton-Noble experiment, the electrodynamic equivalent of the Michelson-Morley experiment." [2]

Now nature distorts this Aether all the time by natural processes that take place. We can see the results and feel this distortion as pressure of the Aether [3 dimensional Space/Time].

If you have ever placed two magnets next to each other you can see and feel the attracting or repelling forces involved in this distortion of Space/Time. We call this magnetic flux but it is the actual Aether you feel and see as movement taking place.

Now if we send electrons down a conductor we find a magnetic flux is generated in accordance to the left hand rule. That is the flux or Aether is moving in the direction or twisting in the direction of the left hand rule based on direction of electron flow or travel.

[See Extraordinary Science, Volume 1, Issue 2, page 9]

In figure 2 I have attempted to show the flux from a moving electron down a conductor. I did not display it as I had wished. In reality, it will look more like a spring as the flux lags the electrons movement through the Aether.

Now we see that not only can nature produce a small space/time distortion with the distortion being the magnetic fields themselves but man can generate the same distortions but controled with electromegnetics. Since this is true then man can get around the demon by bending space/time [Aether] with Scalar technology of which electromagnetics makes up such processes. See Fig. 3.

To bend Space/Time and produce time travel or invisibility you will need to build at least four generators. One of the generators will need to be as a time reference point for the other three generators which control the bending of the X, Y, and Z axis. [See Fig. 4 & 5.]

We will be going over this again and again in the future as I show more and more of the actual mechanism in producing such effects. It is only important to obtain a slight pictorial view of how this application is linked to Scalar Technology.

There is a lot more involved than this simple view I have just given but I hope you have a little better understanding of how a process can actually be produced and what you may be playing with in your search to understand Scalar. Remember I have presented this view on a linear plane of which it is not in reality.

It can be done on a spherical plane but what it will look like will be a mirror image folding in on itself. For now just try to understand it using our 3D Space/Time Cube. This application will fall in the field of The Philadelphia

Experiment, Hyperspace drives and Time travel. We have only begun our journey into Scalar Technology. The UNIFIELD!

References

[1] & [2] Speculations in Science and Technology, Volume 10, Number 1, 1987

A SECOND APPLICATION OF SCALAR TECHNOLOGY: GRAVITY

BY WARREN E. YORK

I wish to point out a correction in FIG.3 of last issue. The direction of the arrows indicating Aether rotation and stated as being the same thing as a magnetic field is shown going in the counter clockwise direction for the positive end or right side of the drawing.

This flow should be changed to show clockwise rotation for the right side or positive side only. This error was noticed due to recent developments and observations of Aether mechanics. This brings me to the correction on the second error which was stated as the Aether and EMF [magnetic flux field] being one in the same thing.

This is half true. It is now my understanding that the Aether flow is inverse to the magnetic flux flow and non symmetrical to it. Fig 2. For those of you who are technicians or professionals, you should be aware of the two electron flow theories.

The first and accepted one is that positive energy travels from positive to negative from a battery or source through a conductor and the not so accepted but also true theory of hole flow.

That is the empty space left in an atom's outer orbit which is like a hole which travels backwards in the conductor. That would be negative to positive.

So the new understanding is that the Aether flow is inverse to magnetic flow. Electrons and Aether flow interact with each other. The next correction is a typo of the word Ether. I had spelled Either and it should be Aether to indicate other than the gas called Ether. [See last issue]

[Fig.3 Extraordinary Science, Jan/Feb/Mar 1990, page 17]

Researchers

Matt Campbell currently employed by the U.S. Government has taken me up on my offer to form a small think tank research team. Matt lives here in El Paso, Texas and has a strong background on the new technologies. He had read my article on Scalar Technologies and found a direct relationship with his own study on Vortexes. He learned I was right here in the same town and called to drop by and compare notes.

We learned we were both studying the same thing and decided to join ideas and reasoning which I have already set into motion under the title Scalar Technologies. Since we have joined forces our deductions have progressed to the engineering of a prototype model test coil. Fig 1A.

Dr. Henry C. Montieth has agreed to work with us and review our work so as to keep us on track and prevent wasted man hours on an improper assumption or an erroneous test run. Dr. Montieth has twenty years of service with Sandia National Laboratory in Albuquerque, New Mexico; he holds a PhD in applied Physics as well as a Master's degree in electrical engineering.

Dr. Montieth has written several papers of which one I will list here under references [19] for those of you who wish to review how he thinks in relation to our work. He knows of Lt. Col Tom Beardon's work and is a theoretical physicist himself. As an educated critic his understanding of our approach will be most helpful in this study.

I am in the process of contacting other researchers but time to fit everything into one day is hard to find. My personal feeling is that the most knowledgeable man in this field I have come across to date is Dr. Moray B. King. I am in hopes he will join us in some behalf in this study in the near future. You may have seen one of his papers here in Extraordinary Science, Oct/Nov/Dec 1989, page 8, Scalar Current. I have talked with him over the phone but to date strange as it may seem we have not had the chance to compare notes and thoughts.

From what I have read of his thinking from his book [Tapping The Zero-Point Energy] we have come up with the same deductions without knowing of each others work. I would also like to give my special thanks to Theodor Ernst Bart a research and development engineer in Switzerland for RCA laboratories. Through his own research in scalar technology he has sent me lab photos Fig 2. showing Aetheric flow using a color TV screen as an instrument. This idea was first suggested and done by Lt. Col Tom Beardon.

In our approach we review the work and papers of others to formulate and engineer working models of our own on the different concepts. In short we are trying to take ideas and concepts and turn them into reality through working experiments and practical devices. Your insight and suggestions are welcome to help formulate and narrow down these tests.

Gravity

In our last issue I had discussed how scalar may relate to interdimensional doorways or windows. Since this time I have obtained a short video of such a process actually taking place. The manipulation of Time and Space itself or better termed manipulation of the Aether.

I did not go into how to actually make a doorway or window but only show how Scalar is a part in the process to develop such a device. Hence when you manipulate time and space you also will have effects of gravity. There is a lot of work to be done with this process and for obvious reasons it is very tricky, involved and dangerous.

Without a time sync or Aether flow lock one could end up with matter embedded within matter as reported in Project Rainbow [Philadelphia Experiment]. Before we can go on to discuss just how scalar technology can produce gravity we need a pictorial view of just what gravity is.

Notice I did not say anti-gravity. That brings us to just what is gravity? Has anybody ever explained the true nature of gravity to you? In other words what gravity really is or its makeup?

Well some people say it is a pressure or outside force and others say it is a wave or something called a graviton that makes it up. Still they have been unable to identify it in a test. We can detect it because we see the effect of it but we cannot describe the nature of just what it really is.

If you look at the equations of EMF or Maxwells equations and those of gravity you will see similarities in nature. If you have ever played with two magnets and seen and felt the fields you are close to just what the true nature of gravity is. If we look at the properties of EMF we find two polarities or charges if electrostatic. That is a minus and a plus.

In EMF, like charges repel and unlike attract. You can see this with the north and south poles of a magnet. Place two souths or two norths together and you will notice the repulsion. Likewise place two like poles together and you will see the attraction.

The earth has a North pole and a South pole just like a magnet. Fig 2A I know what you are thinking, but no, gravity is not a magnetic field or at least not as we know magnetic fields to be. The best way is to give you a pictorial view of the mechanics of gravity.

Take a look at Fig.3A, an electron's graphic orrery and its interactions with the Aether. The Aether is a fluid grid of reciprocating type of energy which is omnidirectional, has duality properties and is that of all time and space is made of; however, I will not go into what the exact nature of the Aether is at this time.

Now when we send this electron down a conductor Fig 5 from outer orbit to outer orbit of each atom in the conductor we are moving on the direction line or "I" the inertia line represented as the X axis. Fig 3A.

Notice in Fig 5 the cone or spiral shaped rotation the Aether and the inverse flow of the magnetic flux field takes. Now in Fig 2A. if you look at the electron in respect as it being earth then you will see its magnetic Aether

inverse flux fields around its axis of rotation or EMF flux fields as north and south poles [labeled "P"].

Now picture all these electrons in the outer orbits of each bit of matter on Earth and the Earth rotating on its pole axis. Fig 1. This is what gives earth its magnetic flux and inverse Aether fields and north and south poles. Fig 2A. The "F" or flux field is what is known as a closed loop of Aether rotation. Keep this in mind for this accounts for the similarities in formulas of electromagnetic fields and gravity formulas.

Electromagnetic having plus or minus or attraction and repulsion and gravity only having attraction. To produce a gravity field all one has to do is create an Aether flow pump which is in one direction. Now how does matter or a planet produce this Aether pump that we observe as gravity? Fig 1 The nucleus of the atom plays a part but once again let's keep it simple and just look at one aspect for now.

Movement of matter through the Aether due to spin on [just for now] the electron causes friction on the Aether. If you move Aether through mass you get gravity. If you move mass through Aether you get inertia.

By the way, the Aether itself causes the spin of the electron. They can effect each other and this is where friction is termed. Time and space is moving through our ball of matter and from another viewpoint matter is moving through time and space, time and space being the Aether or one in the same.

Aether is omnidirectional reciprocating energy and it can impart that energy in the form of rotation of the electron since they interact with each other. Now this friction which is the imparting mechanism between the Aether and the electron and will direct or curve the Aether to an extent from the surface of the electron.

Put a bunch of these little spinning surfaces together and they direct or pump the Aether to the center of the matter in question. Fig 1. Aether being energy with no mass can fill an infinite amount of space at the center with no problem of conflict with itself.

There is no difference in a bucket of Aether or a pinhead of Aether. It takes up no space since it is energy and what space is made of. This also is where the duality of the Aether comes in. By space I also mean empty space or the lack of matter. Matt's vortex technology holds true to this process.

Scalar is a means of engineering controlled vortex in a specific manner to produce a desired effect. Using scalar technology we can produce this Aether pump [Aether Diode] with control. This means that we can produce a gravity point and everything within our field will fall to that point with no effect on the normal gravity field produced by the planet since our new field overrides the earth's field.

With a balance between this new point and the planet's gravity field, or pump, we can have control of field enclosed matter. This is why I did not say anti-gravity for we generate our own gravity which is not really anti-gravity. There is a video tape out which will demonstrate this effect in part.[15] Longitudinal waves, or RC, as Matt and I call it is put through a light bulb [with no gases only a vacuum]. Standard current gives off the glow of photons and heat can be felt from the lamp.

When RC current is used the lamp is brighter, cool to the touch and has new noticeable characteristics besides the color of illumination. First, it has electrostatic characteristics where a copper mesh ribbon will be attracted to the source of the light; and secondly your hand can feel the pressure Aethric flow from the source.

This pressure is omni-radial Aether flow or kin to gravity but not in the form of a monopole direction yet. This is the start of building what can be called a tractor-beam device. That's one that can attract or repel matter as down a laser beam. Dr. Z, I am told, is working on just such a device. Nature produces a monopole flow of Aether all the time in matter and we call this gravity. Fig 1.

Realization of A New Form of Energy Generated - [RC] or Reciprocating Current

In a recent understanding of scalar technology Matt and myself have come to a realization of a new form of energy which is produced and needed to drive this Aether pump to produce gravity.

We are not the first to discover it but the first to go on record calling it RC [Reciprocating Current] Dr. King calls it Scalar Current and Dr. Nikola Tesla called it longitudinal waves.

Now Tesla was known for AC [Alternating Current] and Westinghouse for DC [Direct Current]. Direct current is the current from a battery cell with negative to positive flow [hole theory] or positive to negative flow [electron flow theory].

We can thank Tesla for our using AC voltage today. He found that AC was more efficient and could travel longer distances without need of amplification. We have not done away with DC, for it is still needed in car batteries flashlights, and portable electronic equipment. We do not use DC through the house wiring because AC is the more efficient for this purpose. With RC, DC and AC will still be needed, but RC will have some advantages over AC or DC. RC voltage will travel on the surface of the conductor therefore giving characteristics of superconductivity.

That is to say that resistance will not be of great importance with RC. It is known as cold electrons due to this ability and most incandescent lamps will almost never burn out due to very little heating up of the filament.

You would not be able to use RC voltage on an electric stove or heating blanket or total electric heater.

Another property of RC is electrostatic characteristics. RC voltage will travel down a conductor almost like microwave does in a waveguide.

The E [electric] and B [magnetic] fields have traded positions with the B field being longitudinal now to the conductor. Fig 5A [23]

This is where Tesla got the name longitudinal wave. Matt and I choose to use RC due to it fitting into the scheme of things along with AC and DC.

No big changes will be needed to adapt RC to the now existing wiring. Most likely RC will be generated off the main line used for AC at the point of need. Likewise DC will be used in much the same way as far as application.

I don't think you will find large RC power plants for this would be impractical and not needed. A Tesla coil will produce this RC energy or you may wish to build a coil similar to our test coil being used to map the fields and properties of RC current. Fig 1A,1B & 4A

Unlike this basic construction given here of an RC generator our test coil has eight primaries of which only four are shown in Fig 4A & 1B and my scalar coil described in Jul/Aug/Sep issue as the secondary.

It turns out that coil described in issue Jul/Aug/Sep 1989 Extradordinary Science, page 16 will generate scalar activity but is better used as an induction receiving coil for this RC energy. The coils are self tuned through K1 which is a adjustable induction vibrator. Fig 6A.[22]

I want to recap for just a minute and then present a paper written by Matt Campbell on our work. Matt will be saying the same thing but in a different manner.

Between the two of us we hope you will get a clearer view of the important points we are trying to bring out to assist you in your own research into this fantastic technology and related topics.

Our present work is in mapping of the fields. The following recap is what we have found or are in the process of finding to be true or not true in this research.

1. The Aether exists. It is Time and Space itself. [1]
2. The Aether is reciprocating omnidirectional grid of energy by nature. [19]
3. The Aether and EMF are gyroscopic in nature.
4. The Aether has properties of duality. The Aether is a fluidatic energy Fig 7A. and follows some of the fluid dynamic laws of other known fluids but unique with additional properties being that of a fluidatic energy. Mass and energy properties kind of like the photon. The photon

may be the Aether itself but in a different form. Light is matter ninety degrees to the Aether or our 3D Space/Time and the Aether is light ninety degrees to matter in our 3D Space/Time.[See last Issue]

5. The Aether is relative to the speed of light.
6. The Aether interacts with the electron and perhaps the proton.Fig 4
7. The Aether is an inverse flow of the EMF flux field but non symmetrical. It can form nodel lodes or zones unlike the closed loop of flux in a magnetic field.
8. The fluid flow of Aether reacts on the surface of an electron as the water vortexes do on earth. The flows will be " Hi's to Lo's" but relative to your reference and the poles of spin. Fig 2.
9. Aether moving through Mass gives Gravity effects. Fig 7A
10. Mass moving through the Aether gives Inertia effects. [Like in a Gyro]
11. A conductor moving through a EMF flux field or a EMF flux field moving through a conductor gives electrons.
12. Electrons moving through a conductor gives you EMF flux.
13. In the flux field flow the North and South Pole would be the same as a Lo in Aether flow flux and the equator would be a Hi. Fig 3.
14. Without Aether nothing would exist. It is time/space and existence itself.
15. Scalar technology is but one method of manipulating the Aether but unique do to the results it produces. It is the key factor in studying and understanding gravity, time and relativity.
16. All Aether effects can be obtained and explained from conventional methods now in practice.
17. I suspect the proton and neutron interact with the Aether also.

I feel the neutron has the biggest play in this role of gravity. Further investigation will be needed to find out but the neutron is a happy particle with the same equalness or balance of charge in relationship to mass so to speak as the Aether has an equalness [reciprocating] of high's and lo's in relationship to energy.[2]

To make it simple I feel the neutron tends to lock into the Aether itself due to gyroscopic action and is pulled along with the flow where the electron and proton are only part of the total balance of this vortex where they effect or warp the Aether to each it's own happy balance of the total reciprocation or vortex.[20]

There is much testing and exploring to be done. I hope this will give some of you new insight into your own research and you will share your

findings with the rest of us. This info will only get us into the ballpark but I feel that is a good place to start for we are closer to home plate now then left field where man has been for some time.

The door is only unlocked. It is time to peek in and explore for all mankind both present and past.

BEYOND THE EVENT HORIZON

BY MATT CAMPBELL AND WARREN YORK

Introduction

This paper is the joint research effort of Warren York and myself, telephone conferences with Dr. Henry C. Monteith, G. Harry Stine, Moray B. King, and Oliver Nichelson.

Additional information was provided by private correspondences with James Bozonas. I wish to extend a "THANK-YOU" and note to Peter Lindermann of Boderland Sciences Research Foundation, who unknowingly assisted our research in the video tape TESLA LONGITUDIAL ELECTRICITY.

You had the stars in your hand and you almost let them slip through your fingers. Let the reader please keep in mind that this paper is open to debate and experimentation. Changes to the theories introduced here will appear in later works.

Also a note on the nature of the Aether, namely that as pure energy it reciprocates from highs to lows, and takes on characteristics of duality like a photon but is unique in its own right.

This paper is to show some of the fields of energy associated with relativity and reveal new forms of energy which can be derived from these fields. Future papers will explain the relationships of these forms of energy with the unified field theory and the mechanics of relativity.

The Silvertooth experiment [1] proves that the Aether exists. The nature of the Aether as that of pure energy, flowing like a fluid, elastic like a rubber band, and forming a 3D grid filling all parts of space from microcosmic to macrocosmic scales.[2]

When stress is placed on the Aether grid free energy is produced [3] and the reference point which mankind uses to observe his universe shifts.[4] The Aether is responsible for electrostatics, electromagnetism, gravity, nucleonic forces, and possibly even the mystery of life [5] and consciousness itself. Without the Aether, nothing can exist in the universe as man knows of it today.

Gravity is an illusion manufactured by the Aether flow orienting itself towards the center of a mass. Hence matter behaves like an Aether pump. [6] A mass moving with equal speed with the Aether will feel no gravitational pull,

however when halted in the flow, a resulting " Gravitational " field is felt by the mass. This can be referred to as Aether pressure. Fig. 1

From Fig 1 one can deduct that a " Gravitational Field " increases towards the surface of a mass, decreases from the surface towards the center of said mass, and that no limitation need be placed upon the number of nodal lines depicting Aether pressure since said Aether pressure has no mass.

If the force of gravity pulling down upon a mass towards the center of another mass is an illusion produced by Aether pressure which is Aether flow in one direction, then tidal forces and rotation of cosmic bodies can be explained.[7]

When the Aether flow forms a loop instead of a vector, a magnetic field is the result. The direction of the flow of the nodal lines of force of a magnetic field is also an illusion, produced by the Aether flowing in the opposite direction. See figure 2. [8]

This theory fits the aether model, but remains to be proven. The following depiction of an electrostatic field is also subject to the same test.

In an electron gravity, rotation, magnetic and static fields exist.[2] The same should hold true for the proton. The proton cannot be ignored in the mechanics of the Aether since it constitutes such a large part of the atom.

Logically when one affects the electrons surrounding the nucleus of an atom, then the nucleus must also be affected. Figure 3 depicts the fields associated with an electron.

If the poles are reversed for a proton, the equator becoming a high and the poles becoming a low, then the Aether flow is reversed, causing the proton to act as a sink for the static field and since the electron already acts as a source for the static field, an attraction results between the electron and proton. [9] See figure 4.

Without becoming involved any further in the atomic structure of the atom, electron flow in a conductor will be reviewed since the object of this paper is to map the electromagnetic fields surrounding a conductor when a potential is applied.

Referring to figure 5 When a potential [c] is placed at the ends of conductor [a] the electron [b] begins to accelerate. At this point voltage is almost zero, current is very high, power is almost zero, resistance is nearly zero and power propagation [h] in the form of heat is at the temperature of the rest of the conductor.

A magnetic vorticity [n] forms [f] that is centripetal in nature, and the Aether [g] forms a centrifugal field. When the electron reaches the point of

maximum acceleration at the end of vector [d] voltage is high, current is low, power is high and resistance is high.

Maximum power [s] in the form of heat occurs. Also the electron [b] no longer "feels gravity" since acceleration is complete and the electron [b] is moving at the same rate as the Aether flowing between the potential.

When the potential is removed the opposite occurs in all cases with the exception of the direction of Aether vorticity. See Fig.6.

An Aether vorticity is formed, and the magnetic field becomes centrifugal in nature. From this one can see that the right hand rule for the Aether vortex is the only apparent constant in time, and active when an electron is being accelerated or resisted [10].

Taking this into consideration and Aether vacuum forms between two conductors when a potential is applied or removed, the potentials being in the same direction. See fig. 7.

To reiterate the processes of manufacturing a combined Aether vorticity a potential [c] is placed at the ends of conductors [a] accelerating electron [b] along vector [d] to the point of maximum acceleration [e] producing Aether flow vorticity [f] which is combining the Aether vorticities of conductors [a] and eliminating Aetheric nodal lines of force form between the two conductors producing an Aetheric vacuum between the conductors which grows with time reaching a maximum level at [e] and forming a cone of zero point energy [g].

The elasticity of the Aether is responsible for moving mass offset from the center point between the two conductors as the Aether vacuum increases. This can be demonstrated when a third conductor is placed between the first two and parallel with the same. Figure 8 is an axial view of this process.

When electron flow [b] is initiated through conductors [a] the Aether vortex flow [c] moves electrons [d] from the center to the edge of the middle conductor. This type of current will be called reciprocating current, since the electrons oscillate from the center to the edge and back again in the middle of the conductor.[12]

This reciprocating current is directly related with zero point energy discussed earlier and possess a novel effect which is unusual in electrical theory but can at least be partially explained with modern electrical theory.

Fig.9 Demonstrates the effects reciprocating current produces in a conductor. As electrons [b] move from the center conductor [a] a magnetic vortex is formed[c] which constructs a mirror image of itself.

A resulting magnetic loop [f] is formed along the edge of the conductor [a] which resembles a magnetic monopole when conductor [a] is introduced into a complete circuit. The two magnetic loops formed by the two

electrons are mutually bucking. The center of conductor [a] possess a positive charge and the edge is negative.

Power dissipation in the form of thermal radiation dissipates along the length of the conductor as well in the Y to Z plane. In summary, thermal radiation and the magnetic field forms in the Y-Z plane, and electrostatic potential forms in the X to Y plane.

Note that a capacitor vaguely simulates the same effect, but uses a dielectric instead. This process can be partially recreated with conventional electricity such as AC or DC, but cannot be completely duplicated.

The conductor takes on new characteristics, appearing as a super-conductor since the electrons never reach their maximum speed and are arrested in their paths at the boundary of the conductor.

The electrostatic field formed must exist among the entire length of the conductor in a circuit, causing the conductor to behave like a waveguide. Therefore reciprocating current has minimum power dissipation and transfers its energy with a waveguide effect.

Towards the center of the conductor on the Y-Z plane the magnetic and Aetheric fields cancel, leaving one field accounting for, gravitation.

Recall the Aether grid, if the Aether is cancelled on the X-Y plane and the Y-Z plane, then it still exists on the X-Z plane and manifests itself as gravity.

Gyroscopic precession can control this element. in Fig. 4 when a bucking magnetic vorticity produced in [c] of Fig. 9 encounters the poles of either the electron or proton, the electron or proton must flip ninety degrees towards the center of attraction between the two.

If one flips, the other must also flip to compensate for the bucking fields and reach equilibrium. when this occurs, the rotation of the mass is arrested and a new direction of rotation begins to result.

During this period of change gyroscopic precession attempts to replace the rotation mass in its former position, resulting in a pulling effect, the same force that manifests itself as gravity, inertia and centrifugal force.

If a larger mass consisting of a great number of atoms were subjected to the same process, the effect would constitute all the atoms acting as a gyroscope, and the mass in question should draw itself back to its former position. This is a crude example of a gravitational field generator, [14] a device that forms a difference in Aether pressure in a given direction.

Fig. 10 demonstrates how a small degree of control can be used with these fields to produce specific results. K1 is an adjustable relay. L1A, L1B, L2A, and L2B are electromagnets. B1 and B2 are bifilar windings in series.

A full voltage spike wave is generated by K1. See Fig. 11. On one cycle bucking magnetic fields are produced across B1 and reversed for 2. On the negative cycle the opposite is true.

A reciprocating current occurs across the incandescent bulb. The bulb does not give off heat and should possess electrostatic properties.

A compass placed on the wire should not point perpendicular, but parallel with the wire instead. Aetheric pressure would also be felt around the wire and incandescent bulb. [15]

The primary reason for using bifilar windings is to insure the mutual cancellation of electric current and produce a universal bucking magnetic field. [11] B1 and B2 yield universal magnetic fields. See Fig. 12.

Two electromagnets placed end to end does not do the same thing. See Fig 13. When the different coils are combined as in Fig. 10 zones of zero point energy exist on the X-Z plane, the Y axis and the Y-Z plane. This allows for some degree of control of the Aether grid.

The incandescent bulb can be replaced by a coil. Another coil for the second bifilar winding can be placed on top of the first at a ninety degree intersection and the whole wrapped in a torroidial fashion [16] See Fig. 14.

Upon close examination the scalar fields produced at the intersection of the windings results in gyroscopic precession 13 of the atoms in all planes of 3D space towards one direction and a gravitational field is produced in the given direction. The torroid prevents torque from spinning the coil on its axis.

When a 3-phase spike wave is introduced to the primaries of the separate scalar generators and the three separate torroidial coils are stacked like a sandwich [16] a continuous difference in aether pressure is produced in a given direction resulting in a constant gravitational field in the said direction. See Fig 15 and 16.

This is levitation. If a second set of torroidial coils is placed adjacent to the first, the gravitational vectors will meet in the center. If this is done with all three axis, a strong omnidirectional gravitational field will form. See Fig. 17.

This is the same thing that occurs naturally in a mass. An intense gravitational field will create a singularity at the intersection, thus reversing time.

The power level, phasing and duration of the activation will determine how far back in time [17] the target will travel. This does not violate the laws of casualty or relativity.[18]

For example, if a dice is thrown, only one of six possible outcomes will result. Five other possibilities still exist, and if our target subject travels backwards on the world time line to the moment the dice was first thrown and throws it again, the possibilities of a different outcome are one in five.

The same holds true if said target subject travels backwards in time and prevents his parents from meeting. In order for this to happen, he had to travel back in time. But his genetic structure and life history has been altered.

The life history of our target subject should eventually lead to the construction and operation of the time control device. See Fig. 18.

According to this theory, a very high number of alternate realities exist with each passing event.

In conclusion, it seems to the writer of this paper a humorous trick to use a 1.5 volt battery and a wire to shift mankind's reference point from one possible reality to another, however these theories are open to debate and experimentation.

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THE ELECTROMAGNETIC FIELD & CLERK MAXWELL

ARTICLES BY ALBERT EINSTEIN & THOMAS F. TORRANCE

Introduction

This reference article is included in the aether compilation of articles for a number of reasons. Firstly, it was the understanding of Clerk Maxwell that there existed some form of luminiferous medium which bore the propagation of the electromagnetic field. Secondly, the nature of the electromagnetic field itself is the closest specification that man has made in relation to the nature of light - the medium of his highest physical sense - that of vision.

Thirdly, the summation by Albert Einstein of the work of Clerk Maxwell on the nature of the electromagnetic field is of outstanding resource. In a separate article, entitled Aether and the Theory of Relativity, there may be found a more direct discussion concerning the aether by Albert Einstein. The value of the article found below is its addressing the nature of light, and the scientific specifications thereof.

I am indebted to the the publishers of James Clerk Maxwell - A Dynamical Theory of the Electromagnetic Field - and in particular to its editor, Torrance, who has authored the introduction to this book, and thus the first of the two references which are produced below. They are presented here on a not-for-profit basis, and rather in an effort to provide information for those who know themselves as the students of life. There is currently one further resource which relates to the work of James Clerk Maxwell. It is the outline of a book which he had published in 1882 entitled Matter And Motion.

All the best for now,
Pete Brown
Southern Autumn of 97

James Clerk Maxwell

A Dynamic Theory of the Electromagnetic Field

Introduced and edited by T.F. Torrance (1982)

Three observations may now be offered in concluding this Introduction.

(1) Clerk Maxwell created for the first time a field theory which was independently testable against Newtonian force theories. He created a situation in which the dominance of Newtonian mechanics over the whole spectrum of physical science was called into question and decisive steps were taken in the direction of a non-mechanical thoroughly relational understanding of the intelligible connections immanent in the universe. No doubt Clerk Maxwell did not realise the far-reaching implications of his work which was to change the basic perspective and direction of physical science and alter our understanding of the world of space and time. With reference to Clerk Maxwell's two basic papers, *On Physical Lines of Force* and *A Dynamical Theory of the Electromagnetic Field*, Ivan Tolstoy has recently given us the following appraisal. 'For us, with our hundred or so years of perspective, these two papers - Maxwell's theory of electromagnetism - are a turning point in the history of science.

The theory is, first of all a synthesis - one of the greatest in the history of science. It unifies two kinds of force - the electric and the magnetic - under one: the electromagnetic field. This unification was the direct, logical consequence of Faraday's experimental work; it had a been begun by others - Ampere, Weber, W. Thomson. But Maxwell crystallized this, the first of the modern unified field theories and gave it the mathematical form which remains immortal under the name of Maxwell's equations - a system of relationships between changing electric and magnetic fields - a whole universe of electromagnetic phenomena, miraculously contained in a few lines of elegant mathematics.

(2) Clerk Maxwell's work was of profound conceptual importance for it had the effect of reorganising the epistemological and logical substructure of physical science, not only through his determination of the mathematical properties of radiation which has had immense implications for scientific technology, but through the way in which he conceived and developed the nature of the field and established the reality of the field as the underlying reality of all spatio-temporal phenomena. At this point we cannot do better than let Einstein himself speak.

'The formulation of these equations is the most important event in physics since Newton's time, not only because of their wealth of content, but also because they form a pattern for a new type of law. The characteristic features of Maxwell's equations, appearing in all other equations of modern physics, are summarized in one sentence. Maxwell's equations are laws representing the structure of the field.... All space is the scene of these laws and not, as for mechanical laws, only points in which matter or charges are present.

Moreover, it should be pointed out, that since the epistemological form of Clerk Maxwell's general equations does not depend on the way in which the observer, or the person who measures the fields, is moving, they have the

effect of establishing the objectivity of scientific knowledge in a new and a profounder way than was possible in the post-Newtonian, and certainly, the post-Kantian, outlook upon the universe.

(3) Physical science as it stemmed from Clerk Maxwell's revolutionary ideas was left with a serious, and perhaps an ultimately irresolvable problem, of which, as we have seen, he himself seems to have been aware. This relates to the fact that although his equations expressed the mathematical properties of the energy intrinsic to the continuous field of space and time, he was unable to reconcile in a satisfactory manner, the ways in which the two basic forms of this energy, in respect of position and motion, manifest themselves. Thus, as Einstein has expressed it, while Clerk Maxwell's partial differential equations appeared as the natural expression of the primary realities of physics, in a particular area of theoretical physics,

'the continuous field appeared side by side with the material point as the representative of physical reality. This dualism has to this day not disappeared, disturbing as it must evidently be to any systematic mind.

Clerk Maxwell's problem remains with us in the difficulties that have emerged in the reconciliation of relativity theory and quantum theory, not to mention a unified field theory which will take in thermodynamics and gravity theory as well - although some way toward the solution may well lie along the line of thought which both Michael Faraday and Clerk Maxwell entertained, that the relations between particles in a field of force must be thought of as constituting, in part at least, what particles actually are. However, it is doubtful whether in the nature of the case the duality between particle and field can ever be completely removed any more than the distinction between the temporal and the spatial aspects of space-time.

Maxwell's Influence on the Development

of the Conception of Physical Reality

Albert Einstein

Written for the centenary of Maxwell's birth [1931]

The belief in an external world independent of the observing subject lies at the foundation of all natural science. However, since sense-perceptions only inform us about this external world, or physical reality, indirectly, it is only in a speculative way that it can be grasped by us. Consequently our conceptions of physical reality can never be final. We must always be ready to change these conceptions, i.e. the axiomatic basis of physics, in order to do justice to the facts of observation in the most complete way that is logically possible. In

actual fact, a glance at the development of physics shows that this axiomatic basis has met with radical changes from time to time.

The greatest change in the axiomatic basis of physics, and correspondingly in our conception of the structure of reality, since the foundation of theoretical physics through Newton, came about through the researches of Faraday and Maxwell on electromagnetic phenomena. In what follows we shall try to present this in a more precise way, while taking the earlier and later development into account.

In accordance with Newton's system, physical reality is characterised by concepts of space, time, the material point and force (interaction between material points). Physical events are to be thought of as movements according to law of material points in space. The material point is the only representative of reality in so far as it is subject to change. The concept of the material point is obviously due to observable bodies; one conceived of the material point on the analogy of movable bodies by omitting characteristics of extension, form, spatial locality, and all their 'inner' qualities, retaining only inertia, translation, and the additional concept of force. The material bodies which had psychologically given rise to the formation of the concept of 'material point' had now for their part to be conceived as a system of material points. It is to be noted that this theoretical system is essentially atomistic and mechanistic.

All happening was to be conceived of as purely mechanical, that is, merely as motions of material points according to Newton's laws of motion.

The most unsatisfactory aspect of this theoretical system - apart from the difficulty relating to the concept of 'absolute space' which has recently been brought back into the discussion - lay mainly in the doctrine of light, which Newton quite logically had also thought of as consisting of material points. Even at that time the question must already have been felt acutely: What happens to the material points that constitute light, when light itself is absorbed? Moreover, it is altogether unsatisfactory to introduce into the discussion two quite different kinds of material points which had to be put forward to represent ponderable matter and light. Then later on electrical corpuscles were added as a third sort with fundamentally different properties. Besides, it was a weakness in the basic structure that interacting forces had to be postulated quite arbitrarily to account for what happens. Nevertheless, this conception of reality accomplished a lot. How, then, did the conviction arise that it should be abandoned?

In order to give his system mathematical form at all, Newton had first to invent the concept of the differential quotient, and to draw up the laws of motion in the form of total differential equations - perhaps the greatest intellectual step that it has ever been given to one man to take. Partial differential equations were not needed for this, and Newton did not make any methodical use of

them. Partial differential equations were needed, however, for the formulation of the mechanics of deformable bodies; this is bound up with the fact that in such problems the way and the manner in which bodies were thought of as constructed out of material points did not play a significant part to begin with.

Thus the partial differential equation came into theoretical physics as a servant, but little by little it took on the role of master. This began in the nineteenth century, when under the pressure of observational facts the undulatory theory of light asserted itself. Light in empty space was conceived as a vibration of the ether, and it seemed idle to conceive of this in turn as a conglomeration of material points. Here for the first time partial differential equations appeared as the natural expression of the primary realities of physics. In a particular area of theoretical physics the continuous field appeared side by side with the material point as the representative of physical reality. This dualism has to this day not disappeared, disturbing as it must be to any systematic mind.

If the idea of physical reality had ceased to be purely atomistic, it still remained purely mechanistic for the time being. One still sought to interpret all happening as the motion of inert bodies: indeed one could not at all imagine any other way of conceiving of things. Then came the great revolution which will be linked with the names of Faraday, Maxwell, Hertz for all time. Maxwell had the lion's share in this revolution. He showed that the whole of what was known at that time about light and electromagnetic phenomena could be represented by his famous double system of partial differential equations, in which the electric and the magnetic fields made their appearance as dependent variables. To be sure Maxwell did try to find a way of grounding or justifying these equations through mechanical thought-models. However, he employed several models of this kind side by side, and took none of them really seriously, so that only the equations themselves appeared as the essential matter, and the field forces which appeared in them as ultimate entities not reducible to anything else. By the turn of the century the conception of the electromagnetic field as an irreducible entity was already generally established and serious theorists had given up confidence in the justification, or the possibility, of a mechanical foundation for Maxwell's equations. Soon, on the contrary an attempt was made to give a field-theoretical account of material points and their inertia with the help of Maxwell's field theory, but this attempt did not meet with any ultimate success.

If we disregard the important particular results which Maxwell's life work brought about in important areas of physics, and direct attention to the modification which the conception of physical reality experienced through him, we can say: Before Maxwell people thought of physical reality - in so far as it represented events in nature-as material points, whose changes consist only in motions which are subject to total differential equations. After Maxwell they

thought of physical reality as represented by continuous fields, not mechanically explicable, which are subject to partial differential equations. This change in the conception of reality is the most profound and the most fruitful that physics has experienced since Newton; but it must also be granted that the complete realisation of the programme implied in this idea has not by any means been carried out yet. The successful systems of physics, which have been set up since then, represent rather compromises between these two programmes, which because of their character as compromises bear the mark of what is provisional and logically incomplete, although in some areas they have made great advances. - Of these the first that must be mentioned is Lorentz's theory of electrons, in which the field and electric corpuscles appear beside one another as equivalent elements in the comprehension of reality. There followed the special and general theory of relativity which - although based entirely on field theory considerations-hitherto could not avoid the independent introduction of material points and total differential equations.

The last and most successful creation of theoretical physics, quantum mechanics, differs fundamentally in its principles from the two programmes which we will briefly designate as Newton's and Maxwell's. For the quantities which appear in its laws lay no claim to describe physical reality itself but only the probabilities for the occurrence of one of the physical realities to which attention is being directed. Dirac, to whom in my judgement. we are indebted for the most logically complete account of this theory rightly points to the fact that it would not be easy, for example. to give a theoretical description of a photon in such a way that there would be comprised in the description sufficient reason for a judgement as to whether the photon will pass a polarisator set obliquely in its path or not.

Nevertheless. I am inclined to think that physicists will not be satisfied in the long run with this kind of indirect description of reality, even if an adaptation of the theory to the demand of general relativity can be achieved in a satisfactory way. Then they must surely be brought back to the attempt to realise the programme which may suitably be designated as Maxwellian: a description of physical reality in terms of fields which satisfy partial differential equations in a way that is free from singularities.

BEYOND $E=mc^2$

**A FIRST GLIMPSE OF A POSTMODERN PHYSICS, IN WHICH
MASS, INERTIA AND GRAVITY ARISE FROM UNDERLYING
ELECTROMAGNETIC PROCESSES**

BERNHARD HAISCH, ALFONSO RUEDA & H.E. PUTHOFF

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The most famous of all equations must surely be $E=mc^2$. In popular culture that relation between energy and mass is virtually synonymous with relativity, and Einstein, its originator, has become a symbol of modern physics. The usual interpretation of the equation is that one kind of fundamental physical thing, mass (m in the equation), can be converted into a quite different kind of fundamental physical thing, energy (E in the equation), and vice versa; the two quantities are inextricably intertwined, related by the factor c^2 , the square of the velocity of light. The energy of the sun, for instance, comes from nuclear fusion, in which the nuclei of hydrogen atoms fuse together to become the nuclei of helium atoms. In the prevailing view, mass is lost in the fusion reaction, and as one popular astronomy textbook puts it, "The small fraction of mass that disappears in the process is converted into energy according to the formula $E=mc^2$."

Recent work by us and others now appears to offer a radically different insight into the relation $E=mc^2$, as well as into the very idea of mass itself. To put it simply, the concept of mass may be neither fundamental nor necessary in physics. In the view we will present, Einstein's formula is even more significant than physicists have realized. It is actually a statement about how much energy is required to give the appearance of a certain amount of mass, rather than about the conversion of one fundamental thing, energy, into another fundamental thing, mass.

Indeed, if that view is correct, there is no such thing as mass-only electric charge and energy, which together create the illusion of mass. The physical universe is made up of massless electric charges immersed in a vast, energetic, all-pervasive electromagnetic field. It is the interaction of those charges and the electromagnetic field that creates the appearance of mass. In other words, the magazine you now hold in your hands is massless; properly

understood, it is physically nothing more than a collection of electric charges embedded in a universal energetic electromagnetic field and acted on by the field in such a way as to make you think the magazine has the property of mass. Its apparent weight and solidity arise from the interactions of charges and field.

Besides recasting the prevailing view of mass, this idea would address one of the most profound problems of physics, the riddle of how gravity can be unified with the other three fundamental forces of nature. The electromagnetic force and the weak force, which is responsible for nuclear decay, have been shown to be two manifestations of a single force, appropriately called the electroweak force. There are tantalizing hints that the strong force, which binds nuclei together, will someday be unified with the electroweak force. But until now gravity has resisted all attempts at unification. If the new view is correct, however, gravity would not need to be separately unified. Just as mass would arise from the electromagnetic force, so would gravity.

What is mass? Two key properties define the concept of the mass of a given amount of matter, namely, its inertia and the gravitation to which the matter gives rise. Inertia was defined by Galileo as the property of matter that keeps an object in uniform motion once given an impetus, until the object is acted upon by some further impetus. Galileo's idea was generalized and quantified by Newton in his Principia. The tendency of an object to remain in uniform motion, and the tendency of the motion to change when impetus is applied, Newton expressed in one compact equation. The equation states that the acceleration a , or change of velocity, is proportional to the force F applied, where the constant of proportionality is the inertial mass m of the object in question: thus, $F=ma$.

In other words, inertial mass is the resistance an object offers to being accelerated when it is subjected to a force. In Newton's equation of motion, when the application of a force ceases, the acceleration goes to zero, and the object remains in uniform motion. Objects are assumed to resist acceleration, because that resistance is an innate property of matter.

But try as he might, Newton could not explain the origin of inertia. Imagine, he suggested, that the universe is empty except for a bucket partly filled with water. Furthermore, imagine the shape of the surface of the water: Is it flat? Then the water must be at rest. Is it curved, shaped in cross section like a parabolic reflector? Then the water must be rotating. But rotating with respect to what? That was the profound dilemma that Newton identified. If the universe were truly empty, as his thought experiment required, there would be no background against which the rotation could be measured. But because the shape of the water surface signals whether a rotation is taking place, Newton

concluded that there is a fundamental spatial frame of reference, an "absolute space."

Some 200 years later the nineteenth-century Austrian physicist and philosopher Ernst Mach took a contrary view. To Mach, Newton's thought experiment demonstrated the absurdity of the idea of absolute space. The shape of the water in a rotating bucket, Mach held, was conferred, somehow, through the presence of all the other matter in the universe. Thus Mach agreed with Newton that the property of inertia creates the need for a reference frame; he simply disagreed that such a reference frame could exist as a distinct, absolute entity. Distant matter, however, could define the reference frame. Unfortunately, his conjecture, which has come to be known as Mach's principle, remains more of a philosophical statement than a testable scientific proposition.

In the early twentieth century a number of investigators, including Max Abraham, Hendrik Antoon Lorentz and Henri Poincare, suggested that inertial mass might arise from an effect called electrostatic self-energy. Any charged particle—the electron, for instance—possesses a certain quantity of electric charge. The charge is the source of an electric field, which carries energy—the electrostatic self-energy. It was proposed that the electrostatic self-energy might correspond to the inertial mass of the charged particle, through the equation $E=mc^2$. But the theoretical mass of the electrostatic electron derived from the equation is many orders of magnitude larger than the actual observed mass of the electron, and the self-repulsion of the electrostatic forces would quickly disperse the electrostatic electron. Hence the theory fails.

Our work suggests inertia is a property arising out of the vast, all-pervasive electromagnetic field we mentioned earlier, which is called the zero-point field (ZPF). The name comes from the fact that the field is held to exist in a vacuum—what is commonly thought of as "empty" space—even at the temperature of absolute zero, at which all thermal radiation is absent. The background energy of the vacuum serves as the reference, or zero point, for all processes. To understand how the ZPF might give rise to inertia, one must understand something about the nature of the field itself.

Theoretical considerations indicate that the ZPF should be a background sea of electromagnetic radiation that is both uniform and isotropic (the same in all directions). The reader may already be familiar with a somewhat similar concept: the remnant radiation from the big bang. According to big bang cosmology, the universe began with a titanic explosion, which gave rise to hot, energetic radiation distributed throughout the infant universe. As the universe expanded and cooled, the radiation became much less energetic, but it still pervades space as a faint and nearly isotropic background of microwave radiation.

Like the cosmic microwave background, the ZPF is a sea of radiation that fills the entire universe. There is a major difference, however. The cosmic microwave background has a rather feeble spectrum identical with the spectrum of an object in thermal equilibrium at a temperature of only 2.76 degrees Celsius above absolute zero. In contrast, the ZPF is a highly energetic emission whose predicted radiation spectrum departs radically from the spectrum of an object in thermal equilibrium. Instead of trailing off at high frequencies, the energy of the ZPF continues to rise sharply with the frequency of the radiation. Quantitatively, the energy density is proportional to the cube of the frequency; double the frequency, and the energy increases by a factor of eight. At what frequency the ZPF spectrum finally cuts off or loses its ability to interact with matter are important and still unresolved issues.

A more profound difference between the cosmic microwave background and the ZPF is a result of the origin of the two emissions. When you switch on a lightbulb, the source of the light emission is clear; it is the heat produced by an electric current in the filament. The source of the cosmic microwave background can also be traced to known physical phenomena, namely, the heat radiation associated with the big bang, as modified by the later expansion and cooling of the universe. The origin of the ZPF is more esoteric. In fact, two distinct views about it exist today.

The conventional view traces the ZPF to the laws of quantum mechanics, the theory forged early in the present century to describe the atom. Any electromagnetic field is characterized by the frequency, polarization and direction of propagation of its radiation. A set of values for those three quantities defines a single so-called mode of the field. Every possible mode can be populated by an arbitrary number of photons, the fundamental quanta of electromagnetic radiation. But according to the probabilities calculated in quantum mechanics, even at its minimum energy, each mode will contain one photon half the time and no photons the other half the time. In a field of zero energy each mode would, with certainty, contain no photons, but that is impossible because of the equal probability that each mode also contains one photon. Thus every mode acts, on average, as if it were populated with at least one-half photon (in addition to whatever other natural or man-made radiation happens to be present).

All such modes add up quickly. Since the energy density of the ZPF increases as the cube of the frequency, the amount of energy making up the ZPF is enormous. That energy, in the conventional view, is simply forced into existence by the laws of quantum mechanics. Not surprisingly, it is regarded in quantum fashion as sometimes real and sometimes virtual, depending on the problem at hand.

The competing theory for the origin of the ZPF comes from what has heretofore been an obscure discipline within physics known as stochastic

electrodynamics, a modern version of much earlier twentieth-century investigations by Einstein, Max Planck, Walther Nernst, Ludwig Hopf and Otto Stern. Stochastic electrodynamics postulates that the ZPF is as real as any other radiation field. In such a view the existence of a real ZPF is as fundamental as the existence of the universe itself. The only difference between stochastic electrodynamics and ordinary classical physics is the single assumption of the presence of this all-pervasive, real ZPF, which happens to be an intrinsic part of the universe.

One justification for making such an assumption is that by adding the ZPF to classical physics many quantum phenomena can be derived without invoking the usual laws or logic of quantum mechanics. It is premature to claim that all quantum phenomena could be explained by stochastic electrodynamics (that is, classical physics plus the ZPF), but that claim may one day turn out to be the case. In that event, one would have to make a choice. One could accept the laws of classical physics as only partly true, with a wholly different set of quantum laws required to complete the laws of physics; that is essentially what is done in physics now. Or one could accept the laws of classical physics as the only necessary laws, provided they are supplemented by the presence of the ZPF.

Whether the ZPF arises from quantum laws or is simply an intrinsic part of the universe, an important question remains: Why do people not sense the presence of the radiation if indeed it is made up of real electromagnetic waves spanning the spectrum of radio waves, light and X rays? The idea that space could be filled with a vast sea of energy does seem to contradict everyday experience. The answer to the question lies in the utter uniformity and isotropy of the field. There is no way to sense something that is absolutely the same everywhere, outside and inside everything. To put the matter in everyday terms, if you lie perfectly still in a tub of water at body temperature, you cannot feel the heat of the water.

Motion through a medium almost always gives rise to asymmetries, which then makes it possible to detect the medium. But in the case of the ZPF, motion through space at a constant velocity does not make the field detectable, because the field has the property of being "Lorentz invariant." (Lorentz invariance is a critical difference between the modern ZPF and nineteenth-century concepts of an ether.) The field becomes detectable only when a body is accelerated through space. In the mid-1970s the physicists Paul C. W. Davies, now at the University of Adelaide in Australia, and William G. Unruh, now at the University of British Columbia, showed that as a moving observer accelerates through the ZPF, the ZPF spectrum becomes distorted, and the distortion increases with increasing acceleration. Can the distortion be seen? Yes indeed, but not with one's eyes, because the energies involved are minute.

Although the distortion is small, it is extremely important: our analysis shows that it is the origin of inertia. In an article published last February in *Physical Review A*, we showed that when an electromagnetically interacting particle is accelerated through the ZPF, a force is exerted on the charge; the force is directly proportional to the acceleration but acts in the direction opposite to it. In other words, the charge experiences an electromagnetic force as resistance to acceleration. We interpret the resistance associated with the charge as the very inertia Newton regarded as an innate property of matter. Note that we do not say, "associated with the mass of the particle." In our formulation, the m in Newton's second law of motion, $F=ma$, becomes nothing more than a coupling constant between acceleration and an external electromagnetic force. Thus what we are proposing is that Newton's second law can be derived from the laws of electrodynamics, provided one assumes an underlying zero-point field.

Our work suggests that the conventional Newtonian idea of mass must be boldly reinterpreted. If we are correct, physical theory need no longer suppose that there is something called mass having an innate property, inertia, that resists acceleration; what is really happening, instead, is that an electromagnetic force acts on the charge inside matter to create the effect of inertia. Indeed, it appears that the more parsimonious interpretation is not even that there is charge lurking "inside matter," but that there is only charge. The presence of charge and its interaction with the ZPF creates the forces we all experience and attribute to the existence of matter. Our interpretation would apply even to an electrically neutral particle such as the neutron, because the neutron, at the most fundamental level, is thought to be made up of smaller particles called quarks, which do carry electric charge.

We have had little to say so far about the second key property for the concept of mass, the gravitation to which matter gives rise. But experimental evidence shows that an object's inertial mass, or its resistance to acceleration, is equivalent to the object's gravitational mass, or its mass in a gravitational field. Einstein's general theory of relativity is based on the assumption that inertial and gravitational mass are equivalent and indistinguishable—the so-called principle of equivalence. Hence it stands to reason that if the ZPF gives rise to the phenomenon of inertia, it must also in some way generate the effect of gravity. This audacious idea was proposed as early as 1968 by the Russian physicist and dissident Andrei D. Sakharov, but he never fully developed the concept into a scientific theory.

In 1989 the idea was taken up by one of us (Puthoff) and formulated within the framework of stochastic electrodynamics into a preliminary but quantifiable, nonrelativistic representation of Newtonian gravitation. The underlying principle is remarkably intuitive. If a charged particle is subjected to ZPF interactions, it will be forced to fluctuate in response to the random jostlings of the

electromagnetic waves of the ZPF. Moreover, since the ZPF is all-pervasive, charged particles everywhere in the universe will be forced to fluctuate. Now a basic result from classical electrodynamics is that a fluctuating electric charge emits an electromagnetic radiation field. The result is that all charges in the universe will emit secondary electromagnetic fields in response to their interactions with the primary field, the ZPF.

The secondary electromagnetic fields turn out to have a remarkable property. Between any two particles they give rise to an attractive force. The force is much weaker than the ordinary attractive or repulsive forces between two stationary electric charges, and it is always attractive, whether the charges are positive or negative. The result is that the secondary fields give rise to an attractive force we propose may be identified with gravity.

It is important to note that the fluctuations are relativistic-that is, the charges move at velocities at or close to the speed of light. The energy associated with the fluctuations-which for historical reasons is given the German name *zitterbewegung*, or trembling movement-is interpreted as the energy equivalent of gravitational rest mass. Since the gravitational force is caused by the trembling motion, there is no need to speak any longer of a gravitational mass as the source of gravitation. The source of gravitation is the driven motion of a charge, not the attractive power of the thing physicists are used to thinking of as mass. To interpret Einstein's equation $E=mc^2$, we would say that mass is not equivalent to energy. Mass is energy.

Naturally there are a host of objections that have been or can be raised to our radical interpretation of mass. One important objection is that for gravity our model so far is nonrelativistic, whereas the *zitterbewegung* motions are relativistic. Another possible objection is that we treat the ZPF as real, not virtual, as conventional quantum theory does-even though real, measurable forces can be attributed to it. One such force is the so-called Casimir force between two parallel plates.

It is also claimed that if the ZPF really exists, it would be such an enormous source of gravitational force that the radius of curvature of the universe would be several orders of magnitude smaller than the nucleus of an atom. Of course, such a conclusion directly conflicts with everyday experience. The fallacy in the argument is that in the Sakharov-Puthoff model the ZPF as a whole would not itself gravitate. The gravitational force results from perturbations of the ZPF in the presence of matter. In the Sakharov-Puthoff model, then, the uniform ZPF is not a gravitational source and hence would not contribute to curving the universe.

A third large question also remains to be answered. How can our theory of Newtonian-like gravity be reconciled with twentieth-century measurements of effects predicted only from general relativity? How, for example, can our theory

account for the gravitational deflection of light, the measurement of which in 1919 served as the first proof of general relativity? On that point we can only conjecture. Sakharov suggested accounting for the effects of general relativity by introducing the concept of an "elasticity of space," analogous to the well-known curvature of space-time. The answer could also lie in the proper treatment of the so-called Dirac sea of particle-antiparticle pairs. The question of general relativistic effects, however, is a valid concern that legitimately challenges the interrelated ZPF concepts of gravity and inertia.

Serious as the objection appears to be, we propose that it is prudent to suspend judgment. A great deal of work lies ahead to test and refine our concepts. We and others will continue to study the problem, and in due course the theoretical foundations of those proposals will either be verified or be shown to contain some irreparable flaw. As controversial as the ideas and their implications might be, however, we are encouraged that we are on the right track because of a second analysis now being carried out by one of us (Rueda). In the new analysis it appears that you obtain the same electromagnetic relation between force and acceleration as you get in the original analysis, yet the approach is entirely different. We also submit that a theory that offers new insights with elegance and simplicity is a compelling approach to reality, and we suggest that our view of inertial and gravitational mass has a certain elegance and simplicity.

If our ideas prove to be correct, they will point to revisions in the understanding of physics at the most fundamental level. Even if our approach based on stochastic electrodynamics turns out to be flawed, the idea that the vacuum is involved in the creation of inertia is bound to stay. Perhaps even bolder than the concepts themselves are their implications. If inertia and gravity are like other manifestations of electromagnetic phenomena, it might someday be possible to manipulate them by advanced engineering techniques. That possibility, however remote, makes a compelling case for pressing on with the work.

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EINSTEIN SPATIAL ETHER SINK PARADIGM:

BIG BANG - RAISIN BREAD THEORY AND PHOTON ABSORPTION

SUGGEST MECHANISMS UNDERLYING GENERAL RELATIVITY

BY HENRY C. WARREN JR.

General Relativity (GR) has some perplexing aspects such as

1. Suggesting singularities
2. Failing to explain how mass causes the curvature of space; and
3. Failing to predict the Casimir Effect (CE), which must affect, gravitational measurements since it and conventional gravity coexist.

Regarding singularities as mathematical misstatements and curved space as the result of a more fundamental process, this paper proposes that a different reality underlies the Riemannian math of GR than Einstein assumed. Curvature is seen as a result, not a cause of gravity.

I believe the following paradigm fulfills the requirements of being the simplest, most easily understood, adequate theory of gravity.

Lacking the mathematical ability to validate or invalidate it, I am hoping that someone who has this ability will be intrigued enough to do the suggested tests in whole or in part.

Introduction

I do not know what space is. But General Relativity warps it and has it steer mass and light. Big Bang Theory expands it. Raisin Bread Cosmology has it carry matter and energy along for the ride. The Dynamic Vacuum perturbs it. Some theorists loop it. Some state that matter cannot exist outside it and some even insist there is no outside. All the foregoing suggest that space - or the fabric thereof - is substantive. It is important when thinking about space to keep concepts straight. Matter and energy do not disappear when they "annihilate" they become photons i.e. gamma rays, etc. Nor do matter - antimatter pairs spring from nothing, but from radiation or other particles. Further, Bell's Theorem and Alain Aspect's experiments and the Dynamic

Vacuum suggest that there exists an underlying spatial reality to which we may be electromagnetically blind.

Einstein believed he had eliminated the need for an ether with Special Relativity, but with General Relativity, he in effect substituted space itself for that ether. In a 1920 lecture Einstein acknowledged the necessity of an ether, although he insisted that the properties of the ether must not violate Special Relativity. What GR did was rename the ether and call it space; an unfortunate choice of terminology as it makes intentional reference to truly empty space, difficult. Some physicists seem unclear regarding this issue, sometimes referring to space as if it were truly empty and at other times as if it were substantive.

Left to my own devices, I would prefer using expressions such as fabric of space or medium in space without spelling out precisely the nature of that fabric or medium. It may be that the Plank length is an indicator of the mesh of this fabric, but this may be an artifact of the fact that we and our measuring devices are electromagnetic in nature. However, the impact of Einstein's terminology cannot be ignored. Also, I sense possible similarities between the strings of some modern theories and the fluctuations of certain Casimir type models and the aetherons of some ether based theories. With that and Einstein's 1920 lecture in mind, and with the understanding that a rose by any other name is still a rose and that any theory which assigns physical properties to space is an ether theory, I use the term Einstein Spatial Ether (ESE) instead of space in my paradigm. Where I use the term "space" to refer to the ideas associated with General Relativity I put it in quotes. Coming full circle, I reiterate that the precise nature of space has yet to be comprehended.

I am struck by diagrams of matter streaming toward neutron stars, "black holes" and the great attractor and perceive a similarity between this streaming and Continental Drift. It strikes me that if the universe was generated by the expansion of all of observable "space" and energy from a Big Bang, with space carrying matter along for the ride as proposed in Raisin Bread Cosmology, then the process ought to be reversible.

To put matters in a nutshell, I propose that if one process can emit "space", another can absorb it, with "space" carrying matter and energy along for the ride in both cases.

The absorption and emission of radiation in the form of photons is demonstrated daily in particle accelerators. And the emission and absorption of W particles and gluons is central to much of modern physics. So the notion that gravity is the result of an absorption process is by no means far fetched.

Also, apparently, traditional gravity and the Casimir Effect can be independently demonstrated in the laboratory. Thus, the two phenomena may

exist side by side and interact. The following provides for a simple paradigm of gravity and explores the possible marriage of gravity and the Casimir Effect.

As George Gamov observes in his book *Thirty Years That Shook Physics*, "...if one would assume that light propagates with infinite velocity ..., Einstein's entire theory would reduce to the classical mechanics of Isaac Newton." The finite speed of light and the Lorentz - Fitzgerald Contraction (or transformation) play key roles spelling out the differences.

Because of my limited mathematical ability I take a three step approach:

1. I show how my model produces Newtonian results; then;
2. I attempt to show it will also produce results consistent with General Relativity.
3. I show how my model explains the null results of the Michelson - Morley experiment.

The Model

I propose that the BB process involved the emission, externalization and out-streaming - of space from a preexisting source or state, which I call the Alpha Entity (or state) in order to avoid the baggage associated with the concept of a singularity. Why this occurred no one knows yet; but most scientists believe that it did.

Once emitted, Einstein Spatial Ether obeyed Newton's Laws of Motion and revealed different phases of its personality - including a possible inflationary episode - as it expanded and cooled. Conversely, I propose that the Big Crunch will involve the absorption, internalization and in-streaming of ESE into what I call the Omega Entity, going through another series of phase changes in the process. Thus, I view the expansion process associated with the BB / Alpha Entity as the other side of the coin of that associated with the Big Crunch/Omega Entity and as we shall see: gravitation.

I postulate that all gravitational bodies act as Einstein Spatial Ether Sinks because they soak up and internalize Einstein Spatial Ether, causing in-streaming which carries energy and mass towards themselves in the process. Thus, any Big Crunch, any formation of black holes, and ordinary gravity result from the absorption of ESE including all the matter and energy contained in it. Where does the absorbed Einstein Spatial Ether go? Both Einstein's Principle of the Equivalence of Energy and Matter and Big Bang Theory posit that enormous energy and matter can be incorporated into (stored in) an incredibly small volume. All these processes cause the universe or portions of it to get denser and to occupy less volume, but does not change the overall matter/energy content of the universe. Radiation in all its forms would be an offsetting process.

The unidirectional (monopole) nature of gravity in this model is due to the absorption process causing Einstein Spatial Ether to flow only towards gravitational bodies and not away from them.

It is further posited that as large masses, including the precursor to the Omega Entity, swallow and internalize Einstein Spatial Ether, the mass-energy complex will undergo "phase changes" as it becomes more dense until its appetite for ESE is satiated or because there just isn't any ESE left outside the entity and the process stops.

In this discussion the largest mass in a system being examined, such as a sun, is treated as stationary and the surrounding masses, such as planets and specs of dust, are referred to as inertial masses, although it is unlikely that any mass is truly stationary. The terms body, mass, and sink may be used interchangeably with the understanding that masses are gravitational bodies that act as Einstein Spatial Ether Sinks in this model.

4. Newtonian Consistency

Assume a stationary massive body that soaks up Einstein Spatial Ether, much as a sponge soaks up water. As surrounding ESE streams toward the massive body, it carries all surrounding masses and energy inward as in RBC (Two dimensional examples would be continental drift and a conveyer belt). Thus, in this model gravitational bodies are regarded as Einstein Spatial Ether Sinks (ESES).

But an inertial mass passing by, in addition to being carried along by the in-flowing stream, also acts like a sponge and absorbs Einstein Spatial Ether, helping close the gap between the two masses as they both "reel in the rope of space in a tug of war," which accounts for the attraction between two masses being proportional to the product of the masses.

Like sponges soak water in an aquarium,
mass soaks up the fabric of space in all directions.

"Tug of War Felt at X".

But mass gobbles Einstein Spatial Ether in all directions and the swallowing on the side away from the inertial mass offsets the dynamics of that towards the stationary mass. The effect of this action is to allow the inertial mass to passively drift along with in-streaming conveyer belt of ESE. Thus, the mass of the inertial body can be disregarded when calculating its falling rate, which is why all bodies do fall at the same rate.

The pattern of inflowing Einstein Spatial Ether associated with a mass comprises its gravitational field. Force field geometry causes the velocity of the ESE to increase as a mass is approached. Thus, the Inverse Square Law

applies and the strength of the field varies with the inverse square of the distance and acceleration occurs.

5. Consistency With General Relativity

This model explains Einstein's elevator thought experiment better than the curved space paradigm. It becomes obvious why gravity cannot be distinguished from an acceleration. Gravity is due to an acceleration, the acceleration of Einstein Spatial Ether.

Tidal gravity behaves as in GR. Objects are stretched in the direction of streaming and squeezed perpendicular to it.

The gravitational redshift and gravitational lensing are both explained by this model.

Geodesic travel would occur and flattened surfaces at one instant would undergo Riemannian curvature with the passage of time in the presence of massive bodies because of the radial nature of the ESE streaming. But this curvature is a result of the gravitation not a cause of it.

Appropriate bending of light and advance in the perihelion of Mercury would occur per the calculations referenced toward the end of this homepage.

As light (yellow) travels near a mass it curves,
because space (blue) accelerates and the angles of vectors change.

Inertial mass is tied to gravitational mass, because both result from the same dynamics, the absorption of Einstein Spatial Ether by a gravitational sink.

Gravity and Inertia

Einstein referred to gravity as an apparent or fictional force. But gravitational action has two components, an active component and a passive one.

If true forces are defined as being active and apparent or fictional forces as passive, then the first component, in which space is warped in GR or absorbed in this paradigm, is a true force.

The second, in which mass takes the path of least resistance in GR or drifts with the flow in this paradigm, can be considered an apparent or fictional force.

Einstein Spatial Ether Sinks and Relative Motion

Massive (gravitational) bodies act as Einstein Spatial Ether Sinks (ESES) absorbing space omnidirectionally. The dynamics of the flow of ESE into a massive body forms a gravitational field which obeys the Inverse Square law. The absorption process entrains the ESE being absorbed for an extensive

distance. That is, the field tends to be anchored, tethered or frozen to the gravitational body and travel with it. This is the simple result of Cause and Effect and the fact that the field is a creation of the gravitational body. Thus, the gravitational body (mass or sink) and its associated field form a unit which operates as a system.

The system tends to passively drift or flow with the "Background Einstein Spatial Ether" (ESE not associated with the systems gravitational field) because its interactions with the Background ESE are equal in all directions and it has no reason to behave otherwise. If the Background is not accelerating the system experiences no relative motion with regard to that stream. An inertial gravitational body, with zero forward momentum of its own and absent the application of forces other than gravity, which experiences the gravitational field of a stationary mass will travel with the inflowing ESE stream associated with the stationary body's gravitational sink.

But, because of the Inverse Square Law, a gravitational ESE stream accelerates and relative motion occurs as a result. How other forces operate is not well understood, but other forces also cause accelerations and any acceleration causes relative motion between the affected mass and the background Einstein Spatial Ether.

But these inertial masses continue omnidirectional absorption and the relative motion is not detectable in the immediate vicinity of the mass. This is because the relative motion is mediated by the gravitational field which obeys the Inverse Square Law and a gradient is associated with the system. While the gravitational field can be regarded reaching to infinity, a zone or margin is reached where the impact is negligible that serves as a functional outer limit. Near a mass the gravitational field is strong and under the tight control of the sink and equal inflow of Einstein Spatial Ether prevails. Toward the outer limits the field is so weak that no meaningful relative motion occurs between the system and the background, so resistance to uniform flow by the Background ESE is nil. All the adjustment for relative motion occurs transitionally between the functional outer limits of the field and the immediate vicinity of the mass.

Inertial Mass

Although at a far distance the motion of the system has little or no impact on the surrounding Einstein Spatial Ether, as the system is approached, surrounding space increasingly gets caught up in the dynamics of the system, at first resisting, then going with the flow. The process is modulated by the inertial behavior of space attempting to maintain constant flow into the massive body from all directions. Inertial mass is then a measure of the impact of a gravitational body and its associated field on the larger surrounding ESE. That is, it is a measure of the sink's strength and the need for the larger surrounding

ESE to adjust to the system, even though the gradient associated with the system allows the impact on distant ESE to be nil at a great distance and the uniform motion of a non-accelerating body to occur without resistance.

Acceleration and Inertia

Just as gravity has two components in my model, so does inertia.

The passive component is described by Newton's first law of motion: "An entity will continue at rest or in uniform motion in a straight line, unless a force acts upon it." Cause and Effect require that all entities behave thus. This component has nothing to do with mass and applies to light and Einstein Spatial Ether as well as to massive bodies.

The active or resistive component is that which is associated with the concept of mass, momentum, and the vector component of inertia called centrifugal force. This component is associated with Newton's second and third laws and it is this component on or through which forces operate. This is the component for which gravitational and inertial masses are said to be equal by General Relativity. This component is due to a displacement between a gravitational body (mass or sink) and its own gravitational field.

Linear Inertia and Acceleration

During stationary or uniform motion the mass remains in the center of its own gravitational field. Cause and Effect dictate that this be so as the field is the sink's creation. Thus, mass does not experience its own field during uniform motion.

But when a gravitational body (mass or sink) is accelerated there is a time lag between when it and its associated field adjust to the new situation. The result is that the mass will traverse and experience a part of its own gravitational field, which will attempt to restore the mass to its central place in the system.

I owe this insight to Petr Beckmann's book *Einstein Plus Two* in which he describes a similar processes associated with electromagnetic inertia. He notes that the field about stationary charge or a charge in uniform motion is frozen to it and such a charge does not feel its own field, whereas an accelerated charge catches up to or crosses (my words) and feels its own field. Beckmann uses this dynamic in his analysis of the orbital mechanics of charged particles and Quantum Mechanics.

Because we do not understand how forces other than gravity operate, we will examine this process from two perspectives and get the same result. (Graphic will soon be provided that illustrate these concepts.)

Case1. If we assume that the accelerating force can operate upon the body without disturbing the field, the body will accelerate forward and drag the field along. But the field, having its own momentum, will take some small amount of time to respond. The result is the mass now overtakes a portion of its own field and experiences the backflowing stream more than the forwardly directed stream. The net internal force by the field is counter to its forward acceleration.

Case 2. Now we will examine the more likely scenario. The force operates via the Einstein Spatial Ether, accelerating a stream containing the gravitational body and its field (or a portion thereof). In this case, the field starts to pass the body and the forwardly directed stream is felt more than the backward one. But a time delay occurs before the gravitational body can respond. This is actually a two stage event with two time delays involved. The first is associated with the difference between when the force is applied and the response of the field, and the second is associated with the difference between the response of the field and the response of the gravitational mass. This two stage delay process represents the inertial resistive force. The size of the entrained field, which is determined by the strength of the sink, influences the degree of delay.

The important point is that the same result occurs in both cases. Although I believe that Case 2 is the more likely scenario in most situations, there are times when it is appropriate to think in terms of Case 1. This is analogous to thinking in terms of positive current flow instead of negative electron flow in a wire.

In addition, another phenomenon takes place. Any time there is relative motion between a body and a medium a pressure or bow wave forms in one direction with a thinning or stretching of the medium to the stern. For example, if one places a beach ball in a pond and pushes it forward a bow wave forms in front of the ball. This would be analogous to Case 1.

If one were to hold the beach ball still in a flowing stream a "stern" wave would form on the upstream side with a comparable depletion of stream flow on the downstream side. Let the ball loose and after a short time delay it will flow with the stream. This scenario is analogous to Case 2. I am not suggesting that that the two processes (relative or counter flow and the bow wave) are additive mathematically. The bow wave phenomenon is just an indicator that the volley ball is experiencing delayed action during relative stream flow.

Inertia Associated With Spin

Elsewhere I have analyzed inertia associated with a spinning flywheel in terms of the foregoing dynamics and have shown that the model works. The analysis also reveals that the gravitational field associated with a spinning gravitational body is irrotational at low velocities. That is, the field does not

rotate (or does so very slightly at most) with a body rotating at low velocities. The results of this analysis is consistent with the Michelson - Gale experiment and the behavior of the Foucault pendulum and the behavior of electric fields associated with charged particles. At spin velocities approaching the speed of light Lorentz transformation type calculations become relevant because of the inability of the field to mediate between the sink and the background Einstein Spatial Ether in a timely manner.

1. Michelson - Morley And Special Relativity

The absorption and entrainment components of this paradigm effectively explain the null results of the Michelson-Morley experiment. This aspect of the paradigm is serendipitous. I did not see it coming. I now realize that the Lorentz - FitzGerald Contraction is just a mathematically useful artifact. Michelson, himself, believed that the ether was entrained and never accepted Special Relativity. I have added the concept of a gravitational system with a sink, whose absorption capabilities is the driving force behind this entrainment, and a field that moderates between the relation of a gravitational body and the Background Einstein Spatial Ether.. Thus, there is no relative motion between a gravitational mass and "space" in the body's immediate vicinity and incoming light approaches even a moving mass at the same velocity from all directions. The so called Lorentz - Fitzgerald Contraction is a mathematical adjustment between expectations of what would occur if mass did not absorb and entrain ESE and what occurs because it does. There is no need for slowing clocks or shrinking measuring sticks.

I and several others (including George Marklin, Henry Lindner, and Steven Rado) have independently proposed a test of this hypothesis. We note that all Michelson - Morley experiments have been run tangentially to the surface of the earth. Thus all vector components of in-streaming space canceled. We propose that if the apparatus, or one arm of it, is oriented vertically a drift will be detected.

However, the gravitational redshift and its effect on atomic clocks is real. So is the increase in mass which is associated with increased velocity as long as mass is regarded as a measure of inertia.

Increasing a body's velocity may somehow increase it's ability to absorb Einstein Spatial Ether. At first blush this may seem absurd, but it is consistent with the principle of equivalence of mass and energy and some of the mysterious events revealed in particle accelerators. As one of many possible strange scenarios an electron can emit a photon which can split into a second electron and positron which can then recombine into a photon and be absorbed by a third electron. How does one get an electron and a positron

from a photon emitted by an electron? By the addition of the energy necessary to accelerate the electron to a higher velocity.

Another process may also be relevant.

I owe the following insight to Steven Rado, who in pp 254 - 259 of his book, *Aethro-Kinematics*, has proposed a mechanism based on Aerodynamic principles and Mach number type calculations, which I have adapted to my scheme.

Relative motion of a gravitational body through background Einstein Spatial Ether is easily accommodated at slow velocities because of the negligible impact of the field on the background and visa versa at the margins of the system. As velocities approach the speed of light the ability of the system to modulate between the gravitational body and the background Einstein Spatial Ether and the ability of the background to accommodate such motion declines because the necessary communication cannot exceed the speed of light. At high velocities a particle or body simply travels further during the time adjustment to its behavior is attempted. Thus a pressure or bow wave builds reflective of powerful relative motion, resulting in resistive behavior consistent with the Lorentz - FitzGerald contraction. The inability of adjustment's to a particle's behavior to occur in a timely manner as its velocity approaches that of light is the cause of much nonintuitive phenomena.

Discussion

This model or paradigm was motivated by the obvious circular logic in the steel ball - rubber sheet analogy used by Einstein to demonstrate how mass warps space. Gravity is used there to demonstrate how gravity warps space. The apple stem analogy, which has lately come to replace it after decades of failure by General Relativists to spot the foregoing circular logic, suffers from the defect that it does not show how the ant crawling on the apples surface exerts its effect on the apples shape.

More importantly, the reactions of physicists when I started pointing out the circular logic years ago, caused me to question the meticulousness with which the underlying mechanism of gravity was thought through. I was surprised by more than one case of an established physicist acknowledging the circular nature of the space blanket analogy, while still using it as a teaching tool. Apparently the predictive ability of the math in most cases was so good that inability to explain the underlying mechanism without resorting to circular logic - or just as bad in my opinion, because they really depend upon the same circular logic, embedding diagrams in hyperspace, was brushed aside. I am inclined to refer to the rubber sheet analogy as the space blanket analogy, regarding it as a false comforter.

I assumed from the start that math of both Special and General Relativity must on the whole be good, but that a different reality must underpin this math. This model has mass absorb space not warp it, but the result mathematically should be as if space were Riemannian.

At least one Noble Prize winner has had similar doubts about the curved space paradigm while basically accepting the math. The following is a quote from p147 of Steven Weinberg's Gravitation and Cosmology.

".....At one time it was even hoped that the rest of physics could be brought into a geometric formulation, but this hope has met with disappointment, and the geometric interpretation of the theory of gravity has dwindled to a mere analogy, which lingers in our language like 'metric,' 'affine connection' and 'curvature', but is not otherwise very useful....."

I was not alone in the belief that the underlying mechanism for how gravity works was not understood.

In the May 1994 Scientific American article, Unbearable Lightness, the statement is made that "... researchers have never attained a satisfactory understanding of the fundamental nature of gravity."

In the October 1995 issue of Discover, Ed Belbruno, a mathematician at the U. of Minnesota, is quoted as saying, "...However you have to understand what gravity is and we don't understand it..."

In QED Richard Feynman states, "...Gravitation is, so far, not understandable in terms of other phenomena."

Even Kip Thorne, who in my opinion pushes curved space to the limit, acknowledges in pages 399 through 403 of his book, Black Holes and Time Warps, that a flat space paradigm in which gravity influences the lengths of rulers and the speed of clocks provides the same results as the curved space paradigm.

I started by trying to explain everything using a model based solely on the Casimir Effect and submitted that thinking to several people four or five years ago. Getting no response, perhaps because the Casimir Effect has been regarded as a short range force or just because I am a layman. I took it to mean my ideas were unsound, but I now know that is not necessarily the case. I also now know that Haisch and Rueda and Puthoff are proposing that inertia is a Zero Point Field Lorentz Force, Puthoff treats gravity as a side effect of Zero Point Fluctuations and Yilmaz and Alley treat the gravitational field as having mass energy equivalence and call for a correction to Einstein's field equations. Alan Schwartz is attempting to show that the Casimir Effect causes the Equivalency Principle to not hold precisely.

I will take a detour and discuss my Casimir Effect Paradigm briefly because I am still open to the Casimir Effect playing a modulating role on my

model with one eye on it possibly helping bridge the gap between gravity and electromagnetic phenomena.

Massive bodies have been shown to serve as shields for each other from vacuum dynamics on their distal sides with the result that they are driven together. As they direct the flow of Einstein Spatial Ether towards themselves, massive bodies would project a zone of shielding from dynamics on their distal sides, casting a shadow of calm - a zone of protection - on their proximal sides. The size and "strength" of the zone of protection would be dependent on the size of the respective masses and their separation. The tugging of ESE between two massive bodies could also dampen vacuum dynamics between them, providing another mechanism for the operation of the Casimir Effect.

The fact is conventional gravity and the Casimir Effect do exist side by side and General Relativity has not dealt with this situation. I see similarities between this sink paradigm's and Beckmann's handling of electromagnetic inertia. I also see similarities between the behavior of the Casimir Effect, which conventional wisdom regards as an electromagnetic phenomenon, and that of certain ether theories based on gas law type mechanics. So my present openness regarding the Casimir Effect may not represent a weakness.

Ramifications of the Einstein Spatial Ether Sink Paradigm

This paradigm suggests three possible linkages with quantum dynamics. It shifts the focus from outside massive bodies to internal events, namely, the hunger for and internalization of Einstein Spatial Ether by mass, it points to the similar behavior of gravitational and electromagnetic inertia, and it is open to a possible role by the Casimir Effect.

Although the sponge scenario could be regarded as an explanation of "how mass curves space," both it and the CE scenario really regard curved space as an artifact. Conditions are created for which Einstein's "dimpled space blanket" would be an analogy if it were not for the circular logic used in that analogy. But attention should be focused on the streaming process, not the resulting curvature.

This paradigm differs from General Relativity in its treatment of black holes and what some call singularities. It seems to me that the curved space paradigm attempts to stuff matter and energy into black holes via an external process, namely the warping of "space". The paradigm which I propose is driven by processes internal to black holes, so called singularities, and Omega Entities with "space" being internalized instead of warped.

Some of the phase changes associated with Omega Entity formation may be the converse of those already postulated by BB and Inflationary models, but at least one more additional phase change obviously occurs, because something, the ultimate mass-energy complex, which this paradigm calls the

Alpha Entity existed before the BB. In a sense gravity is most likely a converse of the strong force in that while the strong force operates over a very short distance, gravity ceases to operate at very short distances within high densities as the result of a this final phase change. Such a process "in reverse" has also been proposed in the Inflationary model which suggest a period when space expanded much more rapidly than at present for a very short period of time. Thus the suggestion that a phase might exist where contraction is much slower then evidenced due to present gravitational forces - and ceases altogether - is a reasonable one. It may be that gravity did not become operative until the Higg's field or something like it "crystallized out" and will disappear when that entity or state evaporates.

If "space" is internalized during absorption, there would be decreasing amounts of it outside the precursor to the Omega Entity to apply inward pressure and squeeze the rest of matter out of existence as some relativists predict. The assertion of some that no force can withstand intense gravity is obviously false or there would never have been a BB in the first place. Further, such squeezing scenarios fail to take into consideration the negative feedback mechanism resulting from the decreased gravitational force due to the loss of the matter that was supposedly squeezed out of existence.

Those who believe in Black Holes as more than just dense bodies of matter, have another problem if they also believe that the speed of light cannot be exceeded. In order for light never to escape the gravitational fields of such bodies some process, be it the warping of space or some other mechanism, must be operating faster than the speed of light. Somehow the distance that light travels through "space" must be made to increase faster then the speed of light or gravity must be shown to slow the speed of light, which in turn creates problems for the principles upon which the Hubble expansion is based.

Whether or not the Alpha and Omega conditions are precisely similar; are two separate creatures; or different aspects of one persistent entity The Alpha - Omega Entity; and whether or not the Alpha Entity totally expends itself in the formation of space are begged for the moment. The Omega Entity may not exist as an identifiable state until the end of a long process of gravitational accumulation and consolidation and resulting phase changes. However, the emission, externalization, out-streaming and absorption, internalization, in-streaming processes are consistent with the equivalence of energy and matter, the absorption and emission of photons, and the concept of a dynamic vacuum.

I note that all or nearly all of the major past and present alternatives to this paradigm fall into the trap of having to create something out of nothing, either from a singularity or continuously. This paradigm avoids that pitfall and

assumes that recycling occurs in this case as it does throughout the rest of nature.

Current alternatives to Einstein's warped space scenario tend to fall into two main categories.

1. Casting a shadow or "push" type processes such as proposed in my earlier Casimir Effect analogy and certain tachyon models.

2. "Pull" type processes such as is associated with the Einstein Spatial Ether Sink model.

Those who propose an ideal gas type ether sink model have both "pull" and "push" components. The "pull" or absorption creates a localized rarefaction and the surrounding ether provides the "push".

"Push" models have a problem in that an infinite universe filled with their stuff is required or at some point their model runs out of push and must dissipate.

I am not aware of any infinite thing, only processes. When one divides by zero, one is saying, "I can decide not to divide as many times as I wish." Likewise, there is no limit on the number of times one body can orbit another if ware and tare, friction, etc. can be eliminated. Nor is there any theoretical limit on how long something can last, if certain laws of nature are suspended. Likewise there is no limit on how far the universe can expand into the nothingness beyond, save for any internal constraints possessed by the universe itself. But there is no scientifically documented infinite thing.

"Pull" type models such as mine have the challenge of explaining what causes the sink. I beg the issue of why mass absorbs Einstein Spatial Ether for the moment, much as Einstein begged the issue of how mass warps "space"; but I note that the absorption and emission of photons by electrons and other particles is a well documented fact and I point to the expansion and possible contraction of the universe as involving the same process as my theory. I note only that if one entity can externalize "space", it is not unreasonable to expect another to internalize it. Thus, this paradigm goes one step further in the explanatory process. Streaming, which is here the counterpart to curving "space", is explained as the result of absorption is referenced to other theoretically accepted processes.

Henry Lindner has a home page that describes an ether sink model, which is close to mine. However, his ether does not possess "inertia", a concept which is crucial in my model.

Steven Rado has a home page and a book, which I have referenced previously. In both he uses the terminology sink vortex. I agree with the sink part of his concept, but not the vortex aspect as he applies it to gravity. His use of vortices seems to be more readily applicable to electromagnetism.

I have confidence that the absorption - in streaming - conveyer belt - portion of my model is true. I am gaining an increasing intuition that a linkage with Casimir type processes is valid, if for no other reason then that once the concept of Einstein Spatial Ether is accepted, a mechanism for Casimir type processes is available. A potential bridge to electromagnetic and Quantum Mechanical processes is beginning to take shape in my mind based on electromagnetic inertia, orbital mechanics, Bohm type pilot waves, Bell's Theorem, Alain Aspect's experiments and the understanding that natural processes cannot be less than three dimensional in nature.

It appears that Robert L. Kirkwood in volume 92, number 6 and volume 95, number 4 of Physics Review has done calculations whose results are consistent with the core portion of my paradigm providing appropriate results, including the bending of light and the advance in the perihelion of Mercury. Extensive calculations in Petr Beckmann's book "Einstein Plus Two" are also consistent with an entrained ether theory such as mine fulfilling all predictions of both Special and General Relativity, once again including the bending of light and the advance in the perihelion of Mercury. I hope a competent mathematician will confirm that the above math is valid and applicable to my model and that the experimental test proposed in the author's quote under MICHELSON - MORLEY AND SPECIAL RELATIVITY is done. If the math fits and drift is detected, then I suggest the Einstein Spatial Ether Sink Paradigm or some modification of it as a replacement for the warped space paradigm.

This paradigm leads to further predictions about the universe, which can be read by selecting Further SPECULATION.

ON INTERNAL WORK AND ANTIGRAVITY WITH NEWTON, FARADAY, AND MAXWELL

BY THOMAS E. BEARDEN

Internal work is an eerie kind of thing! There are several things involved. I will try to discuss one or two briefly.

First, Faraday believed fervently that his lines of force existed as taut physical strings (everyone at the time, Faraday included, believed in a MATERIAL ether). So he thought that EM disturbances were simply the disturbances of these taut strings. That was then a transverse string wave.

So to Faraday, "EM shaking" in the ether was just these physical lines of force shaking (like a transverse twanging string wave). NOTE that he just assumed away the body of any string holder to provide the tensile forces on that string! In short, without realizing it he threw away Newton's third law reaction forces from his material strings.

Maxwell stated point blank that he would read no other EM theory until he had thoroughly studied Faraday's work. He also wrote a paper on those physical lines of force. He mathematized them with a tube of force concept.

But he also ASSUMED away the body of the mysterious missing string holder, and also thereby discarded Newton's third law reaction from his electrodynamic theory. The third law is STILL missing from the theory today!

When electrodynamicists do an experiment, say by introducing some EM energy to be absorbed, etc., the third law recoil force and energy DOES appear. It is GENERATED in their experiment, but the cause for it does not appear in their model! So they piously raise their eyes to heaven and say, "Oh, yes, we know that will occur. That's due to Newton's third law."

Well, Newton's third law is a DESCRIPTION of what happens. It is not the CAUSE of anything, being instead of a cause, an EFFECT.

In short, there never were any twanging strings in the vacuum ether, and Faraday's lines of force are not even lines of force! THERE ARE NO FORCES IN THE VACUUM.

In the first place, force is not the primary CAUSE of acceleration of a mass! Force is not SEPARATE from mass. Rigorously, the definition of force is F is identically $d/dt (mv)$. As can be seen, mass is a COMPONENT of force. In the vacuum, all that exists are changes in the vacuum potential. In other words, you get gradients of scalar potential and swirls which we identify as vector potentials or currents of potential.

There is no E-field in the vacuum, for example, in the sense presently used.

Electrodynamics assumes that at every point in the vacuum, there exists

? (1) a point unit north pole,

? (2) a point coulomb of positive electrical charge, and

? (3) a point unit mass.

Electrodynamics theory then describes how those assumed point entities move and react. THAT's what the equations actually describe, the movements of those three entities. They do NOT prescribe what exists in the vacuum, WITHOUT that observable matter being there!

Classical electrodynamics still completely and erroneously assumes the MATERIAL ETHER. You would think they would have got the message since the Michelson Morley experiment in 1888 destroyed the MATERIAL ether. All that happened was that one day the electrodynamicists said, "Okay, so there's no ether! Okay, we are not using one!" And they never changed a cottonpicking equation!

What really happens with a scalar potential at a point, e.g., is that it increases or decreases. Look at the points in the neighborhood around that point of interest.

If the potential increases at the focal point, then it has not yet increased at the points around it at an infinitesimal distance from it. So it has a set of radial gradients all around, with respect to the ambient vacuum potential points in its neighborhood.

Well, each one of those radial gradients is (erroneously) called a force in classical EM. But for each radial there is an opposite and equal radial. Try increasing or decreasing the potential at that point any way you wish, you still produce a set of equal and opposite (bidirectional) EM "forces".

The point is, the waves are always created as PAIRS of equal and opposite waves. It's more like a "rhythmic squeeze" wave than anything else. In the real world, the antiwave portion is actually a phase conjugate, and superposed spatially upon the wave, in each biwave pair.

That's how Whittaker came to show that any scalar potential is a set of biwave pairs. And in each pair, there is a wave and its antiwave (true phase conjugate). But that means that this doesn't generate any NET force!

Voila! It contains excess or minus energy at that point, but it did not translate anything. That increase in the local energy density of vacuum spacetime is ruthlessly a CURVATURE of local ST, in the GR sense.

So what is produced in the vacuum is a GRAVITATIONAL wave, not an EM wave at all! This is consistent with modern gauge theory, when one thinks

long enough about it, because gauge theory regards gravity itself as simply the "restoration of symmetry" when a force of any kind is formed.

In other words, Sakharov's hypothesis is true; gravity is not a separate field in the sense of Maxwell, but is always made from other fields. In fact, it is just NEWTON's THIRD LAW revealing itself, particularly in electrostatics!

Now let's look a little deeper. Suppose we have this harmonic set of wave/antiwave pairs (this scalar potential) coming onto an atom of matter.

Well, the time-forward wave halves get stripped off and interact with the time-forward part of the atom (i.e., the electron shells).

The atom can be regarded as a set of dynamic dipoles, where a positive charge in the nucleus and a negative charge in the electron shells comprise one of the dynamic dipoles.

The dipole is a "splitter" of the G-wave incoming. It splits that thing into two EM waves momentarily.

The forward time wave half interacts with an electron in the electron shells, and the reversed time wave half interacts with the positive charge end of the dipole down in the nucleus.

That generates Newton's third law recoil of the nucleus, which is admitted but usually ignored in electrostatics.

Point is, for all the energy interactions ongoing in the electron shells, there are equal and opposite EM energy interactions ongoing in the nuclei. We ignore the latter.

NOW to the inner work. As you can see, when you do some work on the atom with EM radiation, you simultaneously do some equal and opposite inner work in the nucleus. (One can use this to get antigravity and free energy and all sorts of goodies).

Now in nonlinear optics, one interacts that G-wave (i.e., with its EM biwave pairs) as it is coming in, by nonlinear EM wave interactions such as four-wave mixing. The time-reversed wave half doesn't get to reach the nucleus; instead, it is flipped right back toward where it came from. And along with it goes up to all the energy in any additional pump waves on the atom.

So a phase conjugate mirror, no matter how powerfully pumped, DOES NOT RECOIL when it emits the powerfully amplified phase conjugate replica wave!

The reason is that the MECHANISM generating Newton's third law recoil of the nuclei, did not happen because the cause (the incoming "missing" time-reversed wave half) was redirected before it reached the nucleus.

Now that's an interesting way to intercept the "cause" of internal work, and redirect and use it, BEFORE it comes into its causative interaction to generate internal work.

Now if you continue to do the POSITIVE work half (in the Sweet device, the work done in the load), and in fact increase the positive work half, while simultaneously rejecting the excess negative half, you have a missing "Newton's third law" reaction for the excess positive work being done in the load. That means you have a missing restoration of symmetry, for the excess positive power being done in the load.

That means you have just exactly that much ANTIGRAVITY formed. That is, if restoring symmetry is what exhibiting gravitational force is, then DENYING the restoration of symmetry is what dis-exhibiting (denying) so much gravitational force is.

So by denying the restoration of symmetry for extra power in the load, you create ANTIGRAVITY by just that amount of power.

Let us reason together. Gravitational energy is already known to be (embarrassingly) negative energy. Well, what is "negative energy" in layman's terms? It's just energy that was never there, but does work against you. Again, it's just our old friend Newton's third law, hiding in disguise.

So we get gravity when we let the time-reversed half of the EM waves interact with atomic nuclei.

We get an absence of gravity when those waves come in but the antiwaves do not reach the nucleus and do not interact with the nucleus.

READ THAT AGAIN, THAT'S PURE MAGIC!

So to get antigravity, you bring in some EXCESS phase conjugate (time-reversed) EM energy, together with some excess energy (the other half accompanying it, since you bring them in, in pairs. You let the time-forward half go to the external circuit and the load, and do excess work in the load.

But you do not let the excess part of the incoming time-reversed energy reach the nucleus. Instead, you multiwave-interact with it before it reaches the nuclei. You send it back on its way. So what does that do?

Well, if you bring in extra gravitational energy (cause), and then REPEL it, WHILE LETTING ITS INCOMING FORWARD-TIME MATCHING ENERGY BE DIVERTED TO THE LOAD AND DO WORK IN THE LOAD, that's the exact thing as creating that much ANTIGRAVITATIONAL energy.

In short, that's how you produce antigravity. Or, if you wish, that's how you get a unilateral thrust.

Just point that antigravity thrust in the correct direction, and the unilateral antigravity thrust force will occur in that direction.

For propulsion, then you fly it like a helicopter. With thrust upward, you lift straight up or hover, or lower down gently. By angling the direction to have a forward component, you also move forward while hovering, climbing, lowering, etc..

That was the gist of my theory of gravitation that I got Sparky Sweet to test with the vacuum triode amplifier. I had estimated that it would levitate at about 1500 watts.

But one would get magnetic charges (monopoles) deposited in the barium ferrite magnets as one increased the power above the nominal 500 watts design. So I warned him not to go above 1,000 watts, because the magnets might explode and kill him. (They go off like hand grenades when the yield point is reached, and Sparky did explode a few magnets at various times this way!)

Anyway, he increased the load in 100 watt increments, to 1,000 watts, and that thing reduced its weight on the bench nicely and smoothly by 90 percent. If the experiment had failed, I would have had to go back to the drawing board. But it worked beautifully.

So the gist of the internal work is that you directly involve

? (1) Newton's third law being added back to classical EM,

? (2) turning EM into G and vice versa, <i>(3) putting Faraday's missing string holder back in there,

? (4) increasing the potential cause for internal work, then rerouting it back out before it interacts in the nucleus, and

? (5) finding Maxwell's missing "tensioning agent" in the vacuum.

Maxwell actually pointed out, carefully, that his theory was not finished because he had assumed this stress in the ether, but had not been able to account for it, and therefore further work had to be done.

Heaviside also warned that the present EM theory was just first order, and suitable for first order effects, but was not to be considered as finished.

In his opinion, initially the engineers would have sufficient trouble learning that first order theory and applying it. So the refinement of the theory could come later.

Hope this is a little clearer.

BALANCING FREE ENERGY DEVICES

BY THOMAS E. BEARDEN

I think the way to "balance" the use of free energy may very well come down to this:

First, you can reuse energy over and over. The only real conservation of energy law is that "energy can neither be created nor destroyed. Period."

This means that, when you "use" a joule of energy (e.g., suppose you scatter a joule of incoming energy, in a resistor), then you still have that joule of energy remaining AFTER you've done a joule of work.

So in May this year at the 4th International Energy Conference, I pointed out that you can RETROREFLECT the energy, after it's already "passed through" the circuit, and get it back (or some of it, depending on the reflection coefficient) to "reuse" (i.e. scatter) once again.

I pointed out that this already occurs in intensely scattering media, and provides the well-known anti-Stokes emission phenomenon, which IS DEFINED as emission by the medium of more energy than one puts in! In other words, the fact that one can get overunity has been recognized in the anti-Stokes emission phenomenon for over 30 years.

Now all energy comes from the vacuum. Sorry about that to the electrodynamicists, but if they will read a little particle physics, it has been known for 40 years that any electrical charge or electrical dipole is a "broken symmetry" in the violent energy flux of the vacuum. That's a proven thing.

By definition of "broken symmetry" in a virtual particle flux (which is what the vacuum energy is), particle physics tells us that

? (1) that asymmetrical portion (i.e., the "gated" portion or "extracted" portion) changes from virtual to "observable", and

? (2) that observable energy flow component will be radiating away from the charge or dipole.

Note that electrodynamics doesn't even know what the whack an electrical charge is, much less a dipole! There is presently no definition of electrical charge in physics.

Anyway, the point is that any dipole

? (1) already freely extracts energy from the seething vacuum, due to the dipole's asymmetry in that flux, and

? (2) already puts out an observable flow of energy as a result.

Well, our electrodynamics profs forget to tell us that! Because it doesn't appear in the 130-odd years-old electrodynamics model! But it's been known for over 40 years in particle physics. It would be nice if the various disciplines would "scrub" their older stuff and correct it, when later and different information uncovered in science has falsified it. They don't, at least not in electrodynamics.

Anyway, we have these facts from particle physics:

? (1) an electrical charge freely extracts energy from the vacuum, and

? (2) it outputs that energy as a radial flow away from it, in all directions, and

? (3) that energy flow is of the kind that we call "observable" (i.e., detectable in that it will translate matter under the right conditions).

Well, there is only one kind of observable energy flow from an electrical charge! And that is the so-called Poynting flow S . (Simplest form is $S = E \times H$, although there are expressions also for the absence of the magnetic field and so on.

Also, the real thing is $S = E \times H + G$, as pointed out by Heaviside who independently discovered it about the same time as Poynting. Poynting got the direction wrong by 90 degrees, and missed the other factor G .

In fact, Poynting effectively limited the energy flow vector S to the energy collection flow in a circuit (the Slepian vector $j\text{-}\phi$, for energy density flow).

Well, that throws away almost all of the energy flow extracted from the vacuum by a source dipole in an electrical circuit. Let's put it this way.

The source dipole extracts freely from the vacuum an enormous flow of energy, and sends it out along the external part of the conductors in its external circuit. All space around those conductors (transmission lines) is filled with this Poynting flow.

The total energy flow is enormous. But only a tiny, tiny smidgeon is intercepted by the surface charges in the wires (and components). Just that tiny portion of S that is in a small sheath directly adjacent to the conductor/component surfaces, gets intercepted and diverted (diverged) into the circuit to drive the electrons as $j\text{-}\phi$.

And thereby hangs a tail. All that Poynting got in his derivation was effectively that divergent part. He also got the direction wrong. Heaviside corrected him as to the direction, and also pointed out that THE DIVERGENT COMPONENT OF THE POYNTING FLOW IS ONLY A TINY PORTION OF THE ENTIRE FLOW.

Most of the flow in the space surrounding the circuitry DOES NOT contact those surface charges, DOES not get diverged. So the nondivergent component is huge (nominally about 10×10^{13} times as much energy flow as

our feeble circuits intercept and collect from the small, small local sheath in contact). The divergent component is about $10\text{exp}(-13)$ of the entire S-flow.

Now contrary to the textbook, the Poynting flow is still in virtual form, but it is in ORGANIZED virtual form. So our normal circuits have

? (1) taken enormous energy from the local vacuum, and

? (2) put back almost all that energy, in flowing nondivergent form.

The reason our feeble electrical circuits do not produce lots of general relativity phenomena, stopping watches and clocks, time dilation, etc. is because they are so damned inefficient, almost to the point of extinction!

So you can say that the normal inefficient circuitry only has a "general relativity reaction coefficient" of about $10\text{exp}(-13)$. That means you normally don't have to bother about time effects, curvature of spacetime, conditioning the vacuum, and oddball ST curvature effects on minds and biological systems. The vacuum doesn't locally "condition" very much.

Now if you were to materially increase the efficiency of that localized "interception and divergence" (i.e., collection) by the circuitry or medium or whatever, then as the orders of magnitude increase, you can get appreciable gravitational effects and all the other. In other words, now you are taking out a lot of local energy as virtual flow, BY PROCESSING IT THROUGH THE CIRCUIT AND ITS LOAD TO FORM "OBSERVABLE" PHOTONS.

The precise difference is this: Putting back virtual photon stuff immediately restores the ether (vacuum). Putting back observable photon stuff is actually putting back DISTURBANCES in the overall magnitude of the vacuum, NOT local virtual photon content. And thereby lies the rub!

It means if we get a good "free energy" system, but do work that produces almost totally OBSERVABLE scattered photons, then we have a local vacuum problem.

We are drawing out the energy in its native form, but we are not putting it back in its native form. So we are "continuing to enlarge the hole" in the natural state energy of the local vacuum. And that gives us the problems.

Well, there is an obvious technical solution. We must REPROCESS those observable photons scattered by our loads, back into virtual and uncorrelated photons.

In that case, we would be back to our present power situation: We could draw, collect, and utilize megawatts or gigawatts of power (easily, if we accent those principles of increasing the collection in the circuitry or medium, as I gave in May 1997) if we are careful to reprocess most of the scattered "waste" photons from our work processes, back into virtual photons which inject directly into the native vacuum format.

There's another way to help also. When we draw out a certain rate of NATIVE energy format, and process it into observable format, then instead of just propagating that waste observable energy out of there, we can RETROREFLECT it repeatedly and intensely, and reuse it.

That way, we dig a certain size "hole" in the local vacuum native energy, so to speak, and then stop. We reprocess most of the waste energy, so our overall POTENTIAL (i.e., density of collected energy) can be very great, without getting into all the weird "vacuum conditioning" effects.

That is, we store up an intense reservoir of recycling observable energy, and use and reuse that energy over and over. In the real world, we can only do that so much, but in an intensely scattering medium that can be appreciable (as shown by Patterson's macroscopic adaptation of anti-Stokes emission and by Lawandy's use of colloidal solutions of titanium dioxide (main ingredient in white paint) to achieve great energy gain and lasing without population inversion).

In other words, you set up a given "storage" of "cumulation" of recycling energy. The actual linear flow of the energy can then be enormous, without taking out nearly that much from the native vacuum energy format.

You only have to replenish the losses or inefficiencies of the recovery process.

Say, e.g., that you can get good efficiencies in cumulation recovery so that only $10\exp(-6)$ of the energy is being irretrievably lost. Then you can power substantially large loads without too much fuss from the native vacuum.

AND, you can also apply to those losses a "reprocessing into native format" process, to further reduce the local vacuum environment's degradation.

I have wished for some time that we could get the Department of Energy and the Universities turned on to this type of thing and to overunity. That still seems to be almost a lost cause. They simply can't seem to get it through their heads that only by altering Maxwell's equations (regauging symmetrically, the Lorentz condition) have they ASSUMED AWAY the overunity systems that Maxwell's unregauged equations rigorously allow and prescribe.

And they can't seem to get it through their heads that (electromagnetically) the work-energy theorem $W = (\phi)(q)$ is a special case for ONE-PASS of the Poynting energy flow along and around a circuit, and on off into space.

(You get a completely different version when you use multiple passes by retroreflection (particularly by phase conjugate reflection).

Then you have to use something like $W = (\alpha)(\phi)(q)$, where α is a factor due to multipass, multicollection. In that case, $\alpha < 1.0$ gives you the conventional case, $\alpha = 1.0$ gives the limit of the conventional case, and

alpha1.0 gives you the multiple pass, multiple collections case as demonstrated by anti-Stokes emission.

Anyhow, I hope this overly long expose' helps clarify the problem of powerful overunity mechanisms initiating dramatic alterations of the local vacuum and of spacetime, unless certain precautionary measures are taken.

MASS MODIFICATION EXPERIMENT DEFINITION STUDY

BY ROBERT L FORWARD, FEBRUARY 1996

INFINITE ENERGY MAGAZINE, JULY-AUGUST 1996

Editor's Note: We are publishing this U.S. Air Force technical report by Dr. Robert L. Forward, because it offers excellent introductory material about Zero Point Energy. It also suggests a range of experiments that demonstrate macroscopic effects that ZPE can promote--including possible alterations of inertial mass. As a colleague of Robert Forward, I know that he does not necessarily "buy" the evidence for some of the macroscopic over-unity devices we report on, including "cold fusion." Rut give him time! (He's also an accomplished science fiction writer, so he'll soon have a lot more to write about when O/U devices power his computer.) -- Eugene Mallove

Abstract

The vacuum is proving to be one of the hottest topics in contemporary physics. It is a source of numerous effects: force fields that emerge from nowhere, particles popping in and out of existence, and energetic jitterings with no apparent power source. Many researchers see the vacuum as a central ingredient of 21st Century physics. Some even believe the vacuum may be harnessed to provide a limitless supply of energy. This report summarizes an attempt to find an experiment that would test the Haisch, Rueda, and Puthoff (HRP) conjecture that the mass and inertia of a body are induced effects brought about by changes in the quantum-fluctuation energy of the vacuum. However, it was not possible to identify a definitive experiment. But, it was possible to identify an experiment that might be able to prove or disprove that the inertial mass of a body can be altered by making changes in the vacuum surrounding the body. Other experiments, which do not involve mass modification, but which teach something about the vacuum, were also defined and included in a ranked list of experiments. This report also contains an annotated bibliography and a list of scientists active in the field.

Mass Modification Experiment Definition Study Goals

The goal of this study contract was to define an experiment that could conclusively determine, one way or the other, whether the mass of a body

could be modified by modifying the vacuum fluctuations around or in that body. If the mass of a body can be modified in even a small way, that fact will be of importance to science. If the mass of a body can be modified significantly, that fact will be of importance to Air Force missions.

The study was instigated by the conjectures by Puthoff (1989) and his colleagues Haisch, Rueda, and Puthoff(1994) that the gravitational mass and the inertial mass of a body are induced effects brought about by changes in the fluctuation energy of the vacuum when the body is present. The study was not limited to the Puthoff conjectures. Other theories concerning the various effects of vacuum fluctuations were also considered.

Puthoff, Haisch, and Rueda were contacted in an attempt to identify a definitive experiment. This requires that the theory proposed by Puthoff and colleagues make a numerical prediction of a specific result, and requires that the experimental apparatus have the sensitivity and precision to measure the predicted result to high accuracy. If the experimental result agrees with the theoretical prediction, then the Puthoff conjecture will have been proven to be "correct" (as much as any theory can be proven to be correct), while if the experimental result does not agree with the theoretical prediction, the Puthoff conjecture will have been conclusively proven to be wrong. Unfortunately, it was not possible to identify a definitive experiment. There are experiments presently being undertaken by Puthoff, which, if successful, will prove the Puthoff conjecture correct. The failure of these experiments to produce a result, however, will not prove the Puthoff conjecture wrong, since the theory does not give a firm prediction of the magnitude of the effect being looked for.

It was possible, however, to identify an experiment which might be able to prove or disprove that the inertial mass of a body can be changed by making changes in the vacuum surrounding the body. The theory this experiment is based upon is the well-accepted theory of Quantum Electrodynamics. Much work needs to be done, however, both on the theoretical analysis and the experimental design, before one can say if the experiment is feasible. Other experiments, which do not involve mass modification, but which teach us something about the vacuum, were also defined and included on a ranked list of experiments.

The report also contains an annotated bibliography of the publications used in preparing the report. The papers referenced in the text by an author's name and a date, refer to entries in the bibliography. The report concludes with an annotated list of those scientists active in the field of vacuum fluctuations.

Rationale For Study And Recommended Experiments

At first glance, it might seem that experiments to study the electromagnetic fluctuation energy of the vacuum are so esoteric and so

devoid of practical applications that they should be funded solely by the National Science Foundation, if at all. Yet, experiments to study the vacuum could lead to real advances in space power and propulsion technology as well as expanding our knowledge of basic physics.

The situation is reminiscent of the field of nuclear energy in the 1930s. Scientists were only just beginning to understand the structure of the atom. The element radium had been purified. It violated the law of energy conservation by continuously giving off heat and radiation. It seemed to be an inexhaustible source of "free energy. Uranium, mostly used to give a "vaseline yellow" color to glass, was also known to give off radiation that would fog photographic plates.

Soon scientific knowledge increased. The atoms were a nucleus made of protons and neutrons surrounded by a cloud of electrons. The number of protons and electrons determined the element, while the number of neutrons determined the "isotope" of that element. Finally, scientists realized that the "free energy" coming from certain isotopes of radium and other elements was not really "free" at all. Instead, a small amount of mass m was being converted into large amount of energy E according to the equation $E=mc^2$, where c is the speed of light. Using this equation, "nuclear energy" could be estimated to produce 9×10^{13} joules of energy per gram of mass.

Then, neutrons were found to be capable of fissioning certain isotopes of heavy elements, releasing "nuclear energy" on demand. Even then, "nuclear energy" was not considered very practical. It was thought that either gigantic "atom smashers" or large "atomic piles" would have to be constructed to obtain the "nuclear energy. It was only after much knowledge had been gained about the fission process, and much chemical engineering work had gone into isotope separation techniques, that it was finally realized that nuclear energy could be obtained from highly enriched uranium-235 or plutonium-239, by a technique as physically simple as putting in contact two precisely machined pieces of isotopically purified metal!

Thus, in just a few decades, the esoteric, poorly understood phenomena of "nuclear energy of the atom" went from being a scientific curiosity into being a major technology. In addition to weapons, nuclear energy in the form of plutonium isotopes is being used as the primary power source in NASA deep space missions. Compact nuclear reactors supply larger amounts of power for classified satellites. Nuclear electric propulsion is the technologically preferred method of sending a crewed mission to Mars, and particle bed reactor rockets would be a major component of our space defense shield if we were still at loggerheads with the USSR.

We are now in the 1990s, looking at the esoteric, poorly-understood phenomena of "electromagnetic fluctuation energy of the vacuum." We can

estimate the "vacuum energy density" to be 10^{108} J/cc, and the vacuum mass density to be 10^{94} g/cc, much higher numbers than those associated with nuclear energy. In the same way that we once did not understand the atom, we presently do not understand the vacuum. We need to carry out careful experiments to accurately measure the electromagnetic fluctuations in the vacuum and how those fluctuations affect matter. That is the purpose of the two highest priority experiments. From these experiments, we expect to learn enough to propose additional experiments that will lead to a better understanding of the vacuum and how it affects the inertial and gravitational mass of bodies. This, in turn, could lead to concepts for "control" of the vacuum and control of the mass of an object. I have already shown [Forward (1984)] that it is possible to extract energy from the "electromagnetic fluctuations of the vacuum." The amount of energy that can be extracted using this technique is just a minute fraction of the 10^{108} J/cc that is calculated to be available. But as we learn more about the vacuum, it is expected that better energy extraction techniques can be found. (Perhaps a technique as physically simple as putting in contact two precisely microfabricated sandwiches of ultrafine metaldielectric multilayers?)

One such possible energy extraction experiment is third on the prioritized list of experiments. According to our present theories about the vacuum, if we place a single proton in the center of a cold, empty vacuum chamber, then within one second that proton, driven by the electromagnetic fluctuations of the vacuum, will gain an energy of 1000 eV. Since it only cost us a few eV to ionize a hydrogen atom to obtain the proton and place the proton in the vacuum chamber, there is a substantial gain predicted. At first glance it looks like this experiment provides a source of "free energy," similar to the "free energy" that seemed to come from radium. We are sure that nature is not going to allow us to get away with this violation of the law of energy conservation. We will probably find that the energy is not "free" but is coming from somewhere else--probably from the immense energy density of the vacuum itself.

So, although the field of "electromagnetic fluctuation energy of the vacuum" is admittedly an esoteric, little-understood field, it does seem to have definite potential as an energy source. It also could have the potential of changing the mass of an object. And, since theory predicts that the vacuum has an enormous mass density as well as an enormous energy density, it might one day be possible to interact enough with the vacuum to "push" on it with a "vacuum drive." Alternatively, perhaps one day it might be possible to operate a "vacuum rocket" that uses energy obtained from the vacuum to expel reaction mass also obtained from the vacuum.

An Introductory Tutorial On The Quantum Mechanical Zero

Temperature Electromagnetic Fluctuations Of The Vacuum

The main body of this report discusses a number of possible experiments to measure the effect of the quantum mechanical zero temperature electromagnetic fluctuations of the vacuum on macroscopic objects. This introductory tutorial gives a short background survey of those parts of quantum theory that create in a supposedly empty vacuum, even a vacuum at zero absolute temperature, fluctuating electromagnetic radiation fields and even fluctuating numbers of charged-particle pairs. [This tutorial will attempt to explain "how, but not "why," because nobody knows why nature behaves in this admittedly strange way.]

Quantum Mechanics

The well-accepted Theory of Quantum Mechanics has many aspects. The two aspects that are most important for this tutorial are that:

- (1) Matter and energy are quantized.
- (2) Certain types of measurements cannot be made precisely; there is always some uncertainty in the measurement. (This is called the Heisenberg Uncertainty Principle.)

Quantization Of Matter And Energy

Matter is quantized. A block of matter, although seemingly a continuously dividable substance, is ultimately found to be made up of "quanta" called atoms. An atom consists of a small massive nucleus surrounded by a large cloud of electrons. The electron cloud acts as a "spring" suspension for the mass of the nucleus, and suspends it in its place in the block of matter. This mass-spring system can vibrate. The frequency of vibration is $f = (k/m)^{1/2}$ where k is the spring constant of the electron cloud and m is the mass of the nucleus. The amplitude or energy of the vibration is determined by the temperature of the block. The higher the temperature, the more energy there is (on the average) in the vibrations of the atoms.

The energy of vibration is quantized too. The vibrational energy of the atoms come in "quanta" of energy $e = hf$, where f is the natural frequency of the vibration of the mass-spring, and $h = 6.63 \times 10^{-34}$ has is a very small constant called Planck's ! constant. These vibrational quanta have been named "phonons.

Now here comes the interesting part. When the equations of quantum mechanics are used to determine the "average energy" $\langle E \rangle$ of the vibrations of the atoms, the answer is $\langle E \rangle = [n(T) + 1/2]hf$, where the number of phonons $n(T)$ is a function of temperature such that when $T = 0$ K, $n(T) = 0$. Thus, even at zero temperature, quantum mechanics predicts that each of the atoms will have

an average residual energy of $\langle E \rangle = hf/2$. This residual energy is an average. It is not that the energy of each atom is a "half a phonon," but that roughly half the atoms have one (perhaps more) vibrational quanta or phonons, while the others have no phonon.

The phonon distribution rapidly changes with time as the phonons are passed back and forth between the many atoms. This residual energy at zero absolute temperature predicted by the equations of quantum mechanics is the so-called "Quantum Mechanical Zero Temperature Vibrational Fluctuations of Matter.

This quantum mechanical fluctuation energy of the atoms in matter has been measured by measuring the vibrations in a crystal as the temperature of the crystal is lowered. The experimental data agrees with the predictions of the equations of quantum mechanics, so the quantum mechanical zero temperature vibrational fluctuations of atoms in matter is real. It is this residual quantum mechanical vibrational energy that keeps liquid helium from freezing even when it is cooled to within microdegrees of absolute zero temperature.

Uncertainty Principle

There is a quantum mechanical "reason" for this zero temperature fluctuation energy—the Uncertainty Principle. The Heisenberg Uncertainty Principle of Quantum Mechanics states that it is not possible to precisely measure the position x and the momentum $p=mv$ of a particle at the same time (m is the mass of the particle and v is its velocity). The accuracy of the position measurement Δx and the accuracy of the momentum measurement Δp must obey the relation $\Delta x \Delta p \geq \hbar/2$. If there were no residual vibrational energy in the atoms in the block of matter to keep the nuclei in motion, then at $T=0$ K, the nucleus of each atom would be standing still ($v=0$) and be right in the center of its cloud of electrons ($x=0$), which would violate the Uncertainty Principle. Needless to say, many scientists (including Einstein) have tried hard to come up with an experiment in which the position and momentum of a particle is measured at the same time to an accuracy better than $\Delta x \Delta p \geq \hbar/2$. They all failed, and scientists are now pretty sure that the Uncertainty Principle is more than a "principle," it is a "law" of nature.

There is a corollary to the position-momentum uncertainty pair that will be important later. The Uncertainty Principle also states that it is not possible to precisely measure the energy E of a particle in an infinitely short time t . The accuracy of the energy measurement ΔE of a particle and the time interval Δt in which the energy measurement is made, have to obey the relation $\Delta E \Delta t \geq \hbar/2$.

Electromagnetic Fluctuations Of The Vacuum

With the above as background, we now get to the quantum mechanical zero temperature electromagnetic fluctuations of the vacuum. A region of empty space surrounded by matter at absolute zero temperature would seemly have no energy in it. Yet, since electromagnetic vibrations (light and radio waves) can pass unhindered through the vacuum, the vacuum contains the potential to support these vibrations. If we treat this region of vacuum in the same manner as we treated the block of matter, we can say that the vacuum can support electromagnetic vibrations of frequency f . The quantum mechanical equations for the electromagnetic vibrations in the region of vacuum are identical in mathematical form to the equations for the mass-spring vibrations of the atoms in the block of matter, so the equation for the average energy $\langle E \rangle$ of each of the possible electromagnetic vibrations is the same: $\langle E \rangle = [n(T) + \ln]hf$. Only now, $n(T)$ is the number of photons as a function of temperature, and, as before, when $T=0$ K, $n(T)=0$. But also, as in the atom case, even when T is at absolute zero, quantum mechanics predicts that each possible electromagnetic vibration in the region of vacuum will have a residual average energy of $\langle E \rangle = \frac{1}{2}hf$. This residual energy is an average. It is not that each possible electromagnetic vibration has a "half a photon" but that roughly half the electromagnetic vibrations have one (perhaps more) photons, while the others have no photon.

Now comes the real problem, and the major reason why we need to carry out experiments to verify that the quantum mechanical electromagnetic fluctuations of the vacuum behave as the equations of quantum mechanics predicts. The block of matter has a large, but finite, number of atoms and therefore a finite total quantum mechanical vibrational fluctuation energy. The region of vacuum, however, can support an infinity of electromagnetic vibrations. The region of vacuum cannot support electromagnetic vibrations with wavelengths larger than its largest dimension, but it can certainly support those electromagnetic vibrations with wavelengths smaller than its size, such as infrared, optical, ultraviolet, xray, gamma-ray, etc. vibrations. There is no known limit to how small an electromagnetic wavelength can be. Each of these infinity of possible electromagnetic vibrations has an average energy of $\langle E \rangle = \frac{1}{2}hf$. So, according to this train of logic, a region of vacuum is not empty, but instead is teeming with an infinity of "half-photons" of electromagnetic energy. The famous physicist Richard Feynman estimated that if the minimum wavelength of electromagnetic vibrations was assumed to be approximately the size of a proton, the "energy density" of the vacuum would be 10^{108} J/cc. Equivalently, the vacuum would have a "mass density" of 10^{108} g/cc. This is much greater than typical nuclear densities of 10^{14} g/cc. It is this high predicted energy and mass content of the vacuum that gives rise to the hopes of many that it may be possible to either: extract "free energy" from the

vacuum, "push" on the mass of the vacuum, or use the vacuum mass as "reaction mass.

The quantum physicists explain away this "infinity" of energy by saying that since the vacuum pervades everything, it is only the "differences" in the vacuum energy that are produced by the presence of matter that counts. Needless to say, although the quantum physicists have been able to adjust their equations to cancel out this "infinity" and get the right answers, this is not a philosophically satisfactory solution.

Charged-Particle Pair Fluctuations Of The Vacuum

Not only does quantum mechanics predict that the vacuum is teeming with electromagnetic energy, the uncertainty principle predicts that the vacuum is also teeming with pairs of charged particles called electron-positron pairs. Since the fluctuation photons in the vacuum have energy, then no matter what their energy is supposed to be, there is a finite probability that for a very short time at their energy will be "uncertain" by an amount $\sim E$ that is sufficient to create a positron-electron pair. This event, of course, violates the law of conservation of energy, but quantum mechanics allows the violation to take place provided the positron-electron pair annihilates back into the original low energy photon in a time shorter than the time Δt allowed by the uncertainty relation $\Delta E \Delta t \sim h$. This means that the supposedly empty vacuum is not only full of photons, but also has a tenuous "plasma" of charged positron-electron pairs. This "plasma" makes the vacuum have an index of refraction slightly different than unity and makes it respond non-linearly to strong electromagnetic fields.

Verification

It would be simple to say that since this train of logic concerning the effect of quantum mechanics on the vacuum has led to such ridiculously high estimated energy density levels for supposedly empty space, that there is something wrong with the logic, and the vacuum does not have quantum mechanical electromagnetic fluctuations at zero temperature. Yet experiment after experiment has been carried out whose results can be explained by assuming that the quantum mechanical zero temperature electromagnetic fluctuations of the vacuum are real. One such experiment is the Casimir experiment, described in more detail in the main body of the report. In this experiment, two uncharged conducting plates are put near each other with a vacuum between them. Prior to the introduction of the plates, the region of vacuum between the plates had an infinity of possible electromagnetic vibrations and an infinite amount of quantum mechanical electromagnetic fluctuation energy. Since the plates are conducting, they will short-circuit those

electromagnetic vibrations that do not have zero electric field at the position of the conducting plates. In effect, this cuts in "half" the "infinity" of electromagnetic vibrations allowed in the region of vacuum between the plates. The vacuum now has less energy than it did before the plates were introduced. This "negative energy" in the region of vacuum produces a force on the plates that pulls the plates together. A similar result is predicted when the plates are made of dielectrics instead of conductors. This attractive force can be quite large and has been accurately measured using dielectric plates. These experiments show that indeed, the vacuum does contain quantum mechanical zero temperature electromagnetic fluctuations. Experiments using conducting plates are more difficult and have yet to be done accurately. Such an experiment is at the top of the priority list in the body of the report.

Another important experiment was the Lamb-Retherford experiment, where the frequency of microwave radiation emitted by an excited hydrogen atom was compared with theory. The theory only agreed with the experiments when the theorists assumed that the vacuum between the proton nucleus and the orbiting electron in the hydrogen atom had a tenuous plasma of positron-electron pairs in it, that shifted the electron orbital energy just the right amount to agree with experiment. Thus, this experiment shows that, indeed, the vacuum does contain quantum mechanical charged-particle pair fluctuations at zero temperature.

There are many other experiments and phenomena that can only be explained by assuming that the quantum mechanical zero temperature electromagnetic fluctuations of the vacuum are real. Even such mundane phenomena as the surface tension of liquids and the clumping of smoke particles are explained by assuming that the vacuum contains residual electromagnetic fluctuations even at zero absolute temperature.

Alternate Theory

There does exist an alternate theory. In this "Fluctuating Charged Particle Source Field Theory," it is assumed that although the quantum mechanical zero temperature vibrational fluctuations of atoms in matter do exist, the quantum mechanical zero temperature electromagnetic fluctuations of the vacuum do not exist. (The theory does not explain why one type of fluctuation is allowed and the other is not allowed, it just assumes it.) The theory then goes on to say that all the experiments to date, including the Casimir experiment and the Lamb-Retherford experiment can be explained by saying that: (1) The quantum mechanical zero temperature vibrational fluctuations of matter causes the charged particles in the apparatus to undergo random vibrational fluctuations. (2) These fluctuating charged particle "sources" emit electromagnetic radiation fields that travel through the vacuum where they are "received" by all the other charged particles in the apparatus. (3) The electromagnetic radiation field acts

on the receiving charged particles to cause them to move "in phase" with the transmitting charged particle "sources." (4) The "in phase" motions of the two widely separated charged particles produce correlated forces between the "source" particle and the "receiving" particle that in turn produce the observed experimental results.

Amazingly enough, this alternate theory where the vacuum is assumed to have no fluctuations, seems to make the same predictions as the quantum theory where the vacuum fluctuations are assumed real. There is an experiment that can possibly distinguish between the two theories. It is described in the report.

Summary

There is a lot more to quantum mechanics than quantization of mass and energy and the Heisenberg uncertainty principle, but I hope this introductory tutorial has been enough to help you understand why it is important to learn more about the quantum mechanical zero temperature electromagnetic fluctuations of the vacuum. Hopefully, the experiments proposed in the body of the report, if successfully carried out, can increase our knowledge and eventual applications of this "enigma cloaked in nothingness" called the vacuum.

Ranked List Of Possible Experiments

The following is a list of possible experiments ranked in order in terms of: (1) Improving our understanding of the vacuum. (2) The feasibility of carrying out the experiment. (3) Producing a modification in the gravitational or inertial mass of a body. In the pages following are more detailed discussions of the selected experiments.

1. Measurement of Casimir Force on Conducting Plates

The Casimir force on closely spaced conducting plates has never been measured accurately over a wide range of spacings or a wide range of conducting materials. Such experiments need to be done to verify that the force predicted by Casimir (1948) is real and applies to all conducting plates despite their composition. This experiment is ranked first because it is fundamental and relatively easy to carry out with modest funding. It also has the advantage that once a university or contracting team has carried out the first set of experiments, additional experiments with different conductors and different conductor shapes can be carried out on-site at AFPL with duplicate apparatus.

2. Casimir Stress Induced Anisotropic Inertial Mass Measurement

Scharnhorst (1990) used quantum electrodynamics to predict that the speed of light between two conducting plates is anisotropic, with the speed perpendicular to the plates being greater than c . The anisotropic inertial mass experiment assumes that the mass of a body between two conducting plates will also be anisotropic, and proposes to measure that mass anisotropy using a nuclear magnetic resonance technique developed by Drever (1961). This experiment is ranked second despite its great difficulty, because the theory will give a definite prediction of the magnitude of the mass anisotropy expected, so either a positive or negative experimental result will provide a definitive test.

3. Generating "Subcosmic Rays" in a Cold Vacuum Chamber

Rueda, Haisch, and Cole (1995) predict that the electromagnetic fluctuations in the vacuum will accelerate isolated charged particles to high speeds. The theory predicts energy gains of a proton of the order of 1000 eV per second. This should be easily measured by "releasing" a "cooled" antiproton in a cryogenically cooled electromagnetic trap and measuring how fast it reaches the walls and annihilates. This experiment is ranked third, despite its complexity and cost, because a positive result would "prove" that you can continuously extract unlimited amounts of "free energy" from the vacuum. We know, of course, that nature is not going to let us violate the law of energy conservation, but finding out how nature enforces the energy conservation law will teach us new physics.

4. "Inertia Wind" Experiment

Puthoff, in unpublished work that extrapolates from the paper by Haisch, Rueda, and Puthoff (1994), predicts that a pair of 40 kg masses rotating in a 1 m radius circle at 20 rpm will create an "inertia wind" that will "push" on a sensing mass. He originally predicted the magnitude of the "inertia wind" force would be comparable to the magnitude of the Newtonian force produced by the 40 kg masses. His coauthors are skeptical of the predicted magnitude, and

Puthoff is reworking the calculations to obtain a more definitive prediction. This experiment, despite its simplicity and direct relevance, is ranked fourth because, while a positive result will "prove" the theory, a null result will prove nothing. There are also grave doubts that a large effect of this type would have gone unobserved before now.

In addition to the ranked experiments, there are two additional experiments that are described in the main body of the report, but which are not recommended for consideration because the Principal Investigator was not able to identify an experimental approach that would be able to carry out the desired measurement at the signal-to-noise levels required. Perhaps someone reading this report can devise an experimental approach that will make a measurement feasible.

Nonlinearity of Vacuum Experiments

Ding and Kaplan (1989) proposed to generate second-harmonic photons by focusing laser light on a vacuum containing a magnetic field. This is the only experiment known that can distinguish between the two alternate models for vacuum fluctuation effects, the model where the vacuum itself has electromagnetic fluctuations, and the model where the charged particles in the experimental apparatus are doing the fluctuating. Unfortunately, recent estimates by Kaplan and Ding (1995) on the laser power and magnetic field strengths needed have resulted in numbers that are beyond the capabilities of present lasers and magnets.

Making and Weighing "Casimatter"

Schwartz has recently proposed over the Internet that it might be possible to physically "weigh" the Casimir energy in a sample of "Casimatter" composed of thousands of layers of 80 nm thick aluminum alternating with 50 nm thick magnesium fluoride (MgF₂). The Casimir energy generated between the conducting aluminum plates would make a finite (negative) contribution to the energy and thereby the mass of the Casimatter sample. He proposes weighing the sample of Casimatter, heating the Casimatter to destroy the layer separation, thus eliminating the Casimir energy contribution, then weighing it again. The mass measurement accuracy required is estimated to be greater than a part in 10¹⁷. The force sensitivity levels are beyond the present capabilities of available atomic force microscopes and the accuracy required for a frequency measurement is beyond the capabilities of available clocks.

Measurement Of Casimir Force On Conducting Plates

In a difficult to find, but widely quoted paper entitled, "On the attraction between two perfectly conducting plates," Casimir (1948) predicted that the quantum fluctuations of the vacuum should produce a pressure P or force F per unit area A on two perfectly conducting uncharged plates given by:

$$P = F / A = \frac{\pi^2 \hbar c}{480L^4}$$

where $\hbar = 6.63 \times 10^{-34}$ J·s is Planck's constant, $c = 300$ Mm/s is the speed of light, and L is the separation distance between plates. The appearance of Planck's constant indicates that the effect is due to a quantum mechanical phenomenon. The amazing aspect of the equation is that the predicted force is independent of the material of the plates, as long as they can be considered "perfectly conducting." This means that the equation should be good down to separation distances L that are comparable to the cutoff wavelength of the material.

Everyone assumes that the Casimir force between two conducting plates has been "experimentally demonstrated." It has not. Nearly all the published "Casimir force" experiments used dielectric plates such as glass, quartz, or mica instead, with the most accurate data obtained using cylindrically curved mica surfaces [Israelachvili and Tabor (1972)].

Barton points out that these experiments on dielectrics are not tests of the Casimir force, but instead are tests on the allied but significantly different Van der Waals forces. The Van der Waals force between two dielectric plates is predicted by an equation in the paper by Lifshitz (1956):

$$F / A = \frac{\pi^2 \hbar c}{480L^4} (E - 1/E + 1)^2 \zeta(E)$$

where E is the dielectric constant of the plates, and $\zeta(E)$ is a function that varies from 0.35 when $E=1$ to 1.0 when $E \rightarrow \infty$. It is true the Lifshitz equation turns into the Casimir equation when the dielectric constant is allowed to go to infinity, but anything involving an infinity is suspect.

The last experiments on highly conducting metal plates were carried out by Sparnaay (1958). His measurements on two chromium or two chromium-steel plates did "not seriously deviate from Casimir's predictions, although the attractions found are somewhat too large. No attractions could be measured between two aluminum plates." The data in the Sparnaay paper is of poor quality. Not only was the magnitude of the Casimir coefficient poorly determined, but because of the experimental difficulties the $1/L^4$ behavior with separation distance L was not firmly established, and there was no attempt to

show a failure of the Casimir force law at small plate separations when L is smaller than the cutoff wavelength of the conductor.

The most recent experiments using "conducting" plates were published by Arnold, et al. (1979). These experiments used semiconducting silicon plates rather than highly conducting metal plates. Arnold found a change when the silicon was illuminated to make it more conducting, but the experimental results did not agree well with the Casimir theory.

Sen (1995) at the University of Washington is presently attempting to measure the Casimir force between two gold-plated quartz flats 5 cm in diameter. The experiment is an undergraduate honors project, which will impact on the time and money available to make thorough measurements. There will also be no attempt to make measurements at close plate separations. Serry, et al. (1995) at the University of Illinois at Chicago are planning Casimir force experiments using aluminum plates embedded in and supported by a silicon-fabrication-based microelectromechanical structure. The minimum separation distances obtainable using this fabrication technique should be better than $L=20$ nm. The Casimir forces on the supported aluminum plates can be measured using a modification of a commercially available atomic force microscope. The first goal of the UIC group is to build an "Anharmonic Casimir Oscillator" that will oscillate about an equilibrium between the Casimir force and the force of a spring. Such structures could be used to make precise measurements of the Casimir force at different separation distances L and for different conductors. Onofrio and Carugno (1995) in Italy are also planning a Casimir force experiment between conducting plates using a tunneling electromechanical transducer.

It is recommended that the first priority in proposed experiments to study the properties of the vacuum is an experiment to measure the Casimir force between two conducting plates. The experiment should be carried out with a number of different metals over a wide range of plate separations with an accuracy that can determine not only the coefficient in the Casimir equation, but the $1/L^4$ variation in the force.

The experiments should also be designed to show that the Casimir coefficient and the $1/L^4$ law are independent of the type of conductor used--down to the point where the separation distance becomes comparable to the cutoff wavelength of the metal. That minimal separation distance, in turn, should be a predictable function of the cutoff wavelength of the conductor being used.

The experiments should investigate other structures than parallel plates, since the Casimir force between conductors is not always attractive. A hollow conducting sphere experiences an outward repulsive force [the most accurate recent calculation is by Milton (1978)]. Ambjorn and Wolfram (1983) have derived the Casimir energy per unit volume for conducting rectangular boxes.

Cubes have positive energy and repulsive forces on the walls, long rectangles or parallel plates have negative energy and attractive forces on the walls, while a rectangular box of relative dimensions 1 by 1 by 3.3 has zero Casimir force. It would be desirable to verify these predictions.

Casimir Stress Induced Anisotropic Inertial Mass Measurement

The Casimir stresses on the vacuum space between two conducting plates are anisotropic. Scharnhorst (1990) and Barton (1990) [see also Barton and Scharnhorst (1993)] used this stress anisotropy to predict an anisotropy in the velocity of light. According to their theoretical calculations, the velocity of light parallel to the conducting plates has the speed of light in an unbounded vacuum, $c=c_0$, while the velocity of light perpendicular to the plates has a speed greater than c by the amount:

$$c_{\parallel} / c_0 = 1 + 11 \pi^2 / 8100 a^2 / (L / \lambda_c)^4$$

where L is the spacing between the Casimir plates, the fine structure constant $a=1/137$, and $\lambda_c = h/2m_e c = 2.43 \times 10^{-12} \text{ m} = 2.43 \text{ pm}$ is the reduced Compton wavelength of the electron. Numerically, this amounts to a difference of:

$$c_{\perp} / c_0 = 1 + 1.49 \times 10^{-56} (\text{meters} / L)^4$$

which implies that the speed of light perpendicular to the conducting plates is greater than c .

Some important features of this result are [Barton (1990)]:

(1) This anisotropy of the vacuum space between Casimir plates is calculated to be greater than any dispersion effect, so the phase and group velocities of the light are both given by the same equation and both are greater than c , causing concerns about violation of causality. Fortunately for the sensibilities of those worried about this, Milonni and Svozil (1990) show that Heisenberg uncertainty principle will probably work to prevent the use of faster-than propagation for the reliable transmission of information back in time.

(2) The size of the effect is the same everywhere between the plates except perhaps very near to the surface of the plates where some of the approximations used might not be valid. By very close, Scharnhorst (1990) states "near denotes a distance of a few Compton wavelengths apart from the plates." An electron Compton wavelength is $\lambda_c = 2.43 \text{ pm}$, much smaller than proposed Casimir plate separation distances, typically measured in nm.

Estimate Of Anisotropy Magnitude

It is possible (although difficult) to use ion beam lithography and other sub-micron microelectronic fabrication and processing techniques to construct microelectromechanical structures, such as Casimir volumes, electromagnetic antennas and guides, and atomic force microscopes, with dimensions, spacings, and control of motion accurate to distances of 1 nm (10 Å) or less. Our real limit to the spacing distance L , however, is not our ability to fabricate the required Casimir structures. The theory behind equation (3) assumes that the Casimir plates are conducting at all frequencies of the electromagnetic spectrum. Real metals become transparent in the ultraviolet. The broadest band reflector is aluminum, which has a reflectance of 99% in the long infrared, a reflectance of 90% at a wavelength of 120 nm, and becomes transparent at 10 nm [AIP Handbook 1972], see Table 6g-1, pp 6-124ff and Table 69-2, pp 6-157]. Little data exists between the available 120 nm and the 10 nm data points, but I would estimate that the minimum wavelength at which the Casimir plates can be considered conducting is about $h=60$ nm/cycle, or a reduced wavelength of about $h/2x=10$ nm/rad.

If the theorists agree that equation (3) can be applied to aluminum Casimir plates at a separation distance of $L=10$ nm, then the maximum magnitude of the Scharnhorst effect achievable in a fabricatable piece of apparatus becomes:

$$c1/cII = 1 + 1.49 \times 10^{-24}$$

The question now is: Is it possible to measure such a small anisotropy?

Measurement Of The Scharnhorst Effect On Light Speed

I have been unable to conceive of a method for measuring an anisotropy in the speed of light between two conducting ^{13}C Casimir plates at the level of parts in 10^{-24} . One could think of converting the velocity measurement into a frequency measurement by finding the resonant frequency of a tuned cavity for different Casimir plate spacings, but there are many things other than the Scharnhorst effect that will cause the resonant frequency of a cavity to change.

In addition to the experimental difficulties of making a speed of light measurement, there are theoretical problems that must be addressed first. There have been papers published [Milonni and Svozil (1990) being just one example] which show that the Heisenberg uncertainty principle will produce timing uncertainties in the atoms used to generate and detect the light photons used in the speed measurement. These timing uncertainties will prevent the

accurate measurement of the speed of light or the sending of information faster than c .

Effect Of Casimir Stresses On Inertial Mass

As Landis pointed out in the NASA/JPL Workshop on Advanced Quantum Relativity Theory Propulsion [Bennett, et al. (1995)], if the velocity of light is anisotropic between Casimir plates, then since $m=E/c^2$, perhaps the mass of an object will be anisotropic too. If this is true, it might be easier to measure the anisotropy of inertial mass between Casimir plates than the anisotropy of the velocity of light.

We are not sure that the Casimir stresses will affect the inertial mass of an object. The theory behind the Scharnhorst effect is a perturbation analysis of the inherent nonlinearities in the postulated quantum fluctuations of the electromagnetic fields in the vacuum. Using a simplified model: The fluctuation photons in the vacuum, no matter what their energy, have a finite probability of producing a virtual electronpositron pair with a rest mass energy of 2×511 keV, as long as the pair recombines back into the original photon in a time $\sim t$ shorter than that allowed by the m' Heisenberg uncertainty principle for the energy difference ΔE . In this model, the vacuum has a weak virtual "plasma" of charged particle pairs in it, which makes the vacuum polarizable, and gives the vacuum an index of refraction that is not unity. Scharnhorst's actual calculation was not of the speed of light, but of the index of refraction of the vacuum between Casimir plates. He found that the index of refraction was anisotropic, with the index equal to unity in the directions parallel to the plates and slightly less than unity [see equation (24) of Scharnhorst (1990)] perpendicular to the plates. Scharnhorst then converted this anisotropy in the index of refraction into an anisotropy in the speed of light [see equation (25) of Scharnhorst (1990)]. Since an index of refraction less than unity means a speed of light greater than c , this result gave the Scharnhorst effect its world-wide notoriety.

The important message is that the Scharnhorst calculations showed only that the electromagnetic index of refraction between two conducting Casimir plates is anisotropic. I think everyone agrees that the calculation of the anisotropy in the index of refraction is correct. I also think everyone agrees that an anisotropy in the index of refraction will result in an anisotropy in the speed of light. It is not obvious, however, that an anisotropy in the index of refraction for electromagnetic radiation for the vacuum between two conducting plates will produce an anisotropy in the inertial mass of a body. This needs to be verified by a competent theoretician.

Estimate Of The Scharnhorst Effect On Inertial Mass

I will now assume that the theorists ultimately conclude that, indeed, two conducting Casimir plates will not only produce an anisotropic index of refraction between the plates, and an anisotropic speed of light for photons traveling between the plates, but also an anisotropy in the inertial mass of a body placed between the plates.

The magnitude of the inertial mass anisotropy difference can be estimated by assuming that the total relativistic energy E in the famous equation $E=mc^2$ is a constant that is not affected by the Casimir stress. Substituting the two values for the velocity of light from equation (3) and solving for the mass results in:

$$M1 = E/C^2 = E/c^2 = m_0$$

And

$$M1 = E/c^2 = [1 - 2 \cdot 11^2 / 8100 \cdot a^2 / (L/L_0)^4] m_0$$

Here, m_0 is the scalar inertial mass (assumed to be equal to the scalar rest mass) of the body in an unconstrained vacuum where there are no Casimir stresses, and m_{\perp} and m_{\parallel} are the perpendicular and parallel components of the inertial mass tensor postulated to exist when the body is subjected to Casimir stresses produced by the electromagnetic field constraints resulting from the presence of the two conducting plates.

The assumption that the total relativistic energy of the body, E , is not affected by the presence of the Casimir plates needs to be checked by a competent theoretician. Even if E is also affected by the Casimir stress, it could still turn out that the resultant inertial mass is still an anisotropic tensor, but perhaps by a different factor than that in equation (7).

Under the assumption that equation (7) is valid, and that the calculated Casimir stresses apply for plate separation distances as small as $L=10$ nm, the predicted numerical value for the maximum anisotropy that can be expected in the inertial mass of a body between two conducting Casimir plates is:

$$M_{\perp} / M_{\parallel} = 1 - 3.17 \times 10^{-24}$$

This is a small difference, but 35 years ago, using relatively crude equipment, Drever (1961) measured the anisotropy of the inertial mass of the nucleus of a lithium-7 atom and found the anisotropy to be zero at a sensitivity

level of 5×10^{-23} . If the Drever technique, or something similar to it, could be applied to a sample confined between two conducting Casimir plates, and the sensitivity of the detecting apparatus could be improved by a few orders of magnitude, then it should be possible to measure the anisotropy of inertial mass caused by two conducting plates at the level predicted by the well-accepted theory of quantum electrodynamics. The experiment would thus conclusively demonstrate, one way or the other, whether anisotropic Casimir stresses between two conducting plates can produce a change in the inertial mass of a body.

Hughes-Drever Anisotropic Inertial Mass Null Experiment

The motivation for the Drever experiment [first carried out by Hughes in 1960 at a lower sensitivity was an experimental test of Mach's principle--that the inertial mass of a body may arise from a gravitational coupling with distant matter. Since there is a concentration of matter at the center of our Galaxy, then, depending upon what physical and mathematical models one used for Mach's principle, this excess of nearby matter might result in an anisotropy of inertia along the (bi)direction to the mass excess, which could be detected experimentally as the Earth rotated the apparatus with respect to the Galactic center.

According to some theories referred to by Drever (1961), this anisotropy in inertial mass should cause shifts in the energy levels of atoms and nuclei subjected to a magnetic field. Specifically, in a nucleus with spin $1=3/2$, the energies of the states with magnetic quantum numbers $m= \sim 3/2$ would be increased slightly if the magnetic field were parallel to the direction of the center of the Galaxy, while the energies of the states with $m= \sim 1/2$ would be decreased by an equal amount. If the magnetic field were perpendicular to the direction to the center of the Galaxy, the energies would be shifted in the opposite directions. For the models of inertia being proposed at the time, the predicted ratio of the anisotropy in inertial mass for the nucleus was in the order of 10^{-13} . Drever found it was zero to a sensitivity of 5×10^{-23} .

The isotope used was lithium-7, with a nucleus of spin $1=3/2$, caused by an unpaired $3/2$ proton. The four energy levels of a nucleus of spin $3/2$ in a magnetic field are normally equally spaced. The three resonant frequencies between the four states are the same and there is a single resonance. If the $m=+3/2$ energy levels are shifted with respect to the $m=1/2$ levels, then the single resonance is split into a triplet. The minimum splitting detectable is usually limited by inhomogeneities in the magnetic field, so a weak uniform field is desirable. The magnetic field used in the experiment was the earth's field.

In the experiment, the lithium-7 sample, in the form of a solution of lithium nitrate, was contained in a plastic bottle surrounded by a coil placed with its axis perpendicular to the direction of the earth's field. A direct current through the loop produced a field of about 200 gauss. When this field was switched off rapidly, the resultant nuclear magnetic moment precessed about the earth's field and an alternating e.m.f. signal was generated in the coil. With no anisotropy to cause shifts in the energy levels, there would be a single resonant frequency present and the signal would decay exponentially with a time constant equal to the transverse relaxation time of the spin system. If, however, an anisotropy in inertial mass exists, the resonance response would be split into a close triplet, and the signal would exhibit beats, corresponding to interference between the oscillations at the three resonance frequencies. Very long beat periods would show up as changes in the decay curve shape and 1/e time as the experimental parameters that changed the anisotropy were varied. In Drever's null experiment, the rotation of the earth changed the direction with respect to the Galactic center once a sidereal day. No variation was found. This corresponds to [Drever (1961)]: "an upper limit for the ratio of the anisotropic part of the inertial mass of a proton to the isotropic part of the order of 5×10^{-23} ..

It should be noted at this point that the lithium-7 nuclei being measured were in a non-symmetric chemical compound, were surrounded by non-symmetric polar water molecules, and a large fraction of them were up against container walls, yet these nonsymmetric surroundings did not induce shifts in the magnetic energy levels that would mimic a differential shift in the energy levels caused by an anisotropic inertial mass of the nucleus.

The fundamental beauty of the Drever experiment is that the nucleus is "self-referencing" in that the $m_l = -3/2$ and $-1/2$ nuclear magnetic states produce identical transition frequencies despite large and non-symmetric changes in the surrounding environment that can produce large changes in the absolute energies of the magnetic states. but do not produce differential shifts between the $3/2$ and $1/2$ states, This probably occurs largely because the nucleus is small in size compared to the distances to neighboring perturbing atoms. It is only when the nucleus itself changes, by developing an anisotropy in inertial mass, that the transition frequencies change with respect to each other and produce the beat notes. The beat notes are the signal that something has happened.

Caveats Concerning Other Effects Masking Scharnhorst Effect

Barton and Scharnhorst point out that there are other effects that may produce a mass anisotropy that may mask the mass anisotropy produced by the Scharnhorst effect. These effects are of first order in a , and therefore much larger. How precisely they might influence any specific measurement would

need to be thought through. There are papers available that discuss these effects, such as G. Barton, "Quantum mechanics of charged particles near a plasma surface," J. Phys. A10, 601 (1977), and for particles between two mirrors in G. Barton, Proc. Roy. Soc. (London) A320, 251 (1970), and an update with applications to a neutral atom in Proc. Poy. Sec. (London) A410, 141 (1987). All of these need to be investigated by a competent theorist before much time is spent on designing experiments.

I suspect, however, that these papers will either produce an "effective mass" or an "effective mass anisotropy" that comes about due to the interaction of the charges in the i-P-S under consideration with the charges in the plasma or mirrors. These are not fundamental changes in the inertial rest mass of the atom, just an "effective mass" induced by the coupling of the atom to its surroundings. I would suspect that these nonsymmetric effects, just like the non-symmetric effects in the original Drever experiment, will not cause a change in the magnetic level spacing. This, however, needs to be proven.

Applying Free Precession To A Casimir Anisotropy Experiment

The Drever measurement was made by using a nuclear magnetic free precession technique on a bottle of water containing lithium nitrate, which gave better relaxation times than other compounds. The frequency of precession in the earth's magnetic field was 800 Hz and the decay time of the signal was 3.7 s. In practice, the signal was weak and it was necessary to use 2.5 liters of sample to obtain an adequate signal-to-noise ratio. It is obvious that much thought and work needs to be done to convert this experiment into one that can be done within the confines of two closely spaced conducting plates.

Extracting the Signal

The free precession signal in the Drever experiment was a radio-frequency signal of about 800 Hz. The radio frequency is proportional to the applied magnetic field. It might be thought that the nearby presence of the conducting Casimir plates would prevent extraction of the signal. It should be possible, however, to design the radio-frequency portions of the detection circuit so that the conducting Casimir plates are part of the circuit. For example, the Casimir plates could also be the capacitor plates of an RLC circuit resonant at the desired radio frequency. Alternatively, the plates could be designed with spiral conductive pattern, so that could simultaneously be a "pickup coil" at the des radio frequency signal band and a "mirror" at optical wavelengths. In another approach, the applied magnetic field could be increased until the signal frequency is in the microwave band. The Casimir plates could then be designed as a "waveguide" with a very small height-to-width ratio, operating in the transverseelectric (TE) mode, to extract the signals in the desired

microwave band in the direction parallel to the conducting plates, while acting as a mirror at optical frequencies in the direction perpendicular to the plates.

Drive signals can be inserted into the sample either by modifying the structure of the conducting plates as mentioned before, or by simply driving the conducting plates hard with a high power signal and having a small portion of the drive power leak through the conducting plates into the sample inside by evanescent wave propagation.

Sample Size

Drever used a 2.5 liter=2.5x10³ cc sample in order to get sufficient signal. The volume in between two 5 cm by 5 cm Casimir plates separated by 10 nm is 2.5x10⁻⁵ cc, or a factor of 10⁸ reduction in sample size and expected signal, even if we used the entire volume, since the Scharnhorst effect is constant everywhere in the region between the plates. Unless some other complication arises, I would propose filling the volume between the Casimir plates entirely with sample in the form of a high resistivity, low loss dielectric (either liquid or solid). A solid dielectric containing the desired 1=3/2 spin nuclei would be especially easy to work with. Starting with a flat substrate, the deposition of a layer of aluminum, a layer of the dielectric with the desired thickness, and another layer of aluminum (perh-E with some structure to allow electromagnetic coupled to the sample), would result in an encapsulated sample ready to test.

The sample volume and output signal can be increased by designing the radio frequency portion of the structure as a long, possibly folded, waveguide, or as a series or folded parallel multiplate capacitor, with the capacitor plates acting also as the conducting Casimir plates.

Effect of Sample on Casimir Stress

The theorists who calculate the expected mass anisotropy effect should be asked to look at the case where the space between the conducting plates is not a vacuum at zero temperature, but a dielectric with a finite index of refraction, a finite (but very high) resistivity, and a finite temperature. Barton (1990) has already done this for the vacuum between conducting plates at a finite temperature. I expect the results of the theoretical calculations will be that the anisotropic Casimir stress remains, although the magnitude may be changed slightly. One expected side effect of filling the cavity with a dielectric sample medium is that although the speed of light will still be anisotropic, the speed of light perpendicular to the plates will no longer be greater than c.

Measurement Sensitivity

The sensitivity of electronic amplifiers has improved substantially in the past 35 years. It is not known whether that improvement has been enough to not only compensate for the decreased sample size, but to also provide additional margin to close the gap between the 5×10^{-23} sensitivity of the Drever measurement and the 3.17×10^{-24} sensitivity needed to measure the Casimir stress induced inertial mass anisotropy as given by equation (8). To improve the signal-to-noise ratio, experts in NMR need to be consulted as to the best nucleus to use, the best compound to put it in, the best host lattice or solution, the optimum magnetic field strength to be applied, the best radio frequency circuit-amplifier combination to extract the response signal, and the best NMR technique to be used (driven resonance or free precession).

Summary

Theorists using the well-accepted theory of Quantum Electrodynamics to calculate the effects of the quantum fluctuations in the vacuum, predict that the velocity of light can be changed by Casimir stresses induced in the vacuum by the presence of a pair of closely spaced conducting plates. It is not yet known, but it is suspected, that the same Casimir stresses will cause a change in the inertial mass of an object. The effect is minute, but it may be possible to design an experiment using a nuclear magnetic resonance free precession technique to measure that change in the inertial mass. The result of the experiment will either be that the inertial mass of a body can be changed, or that our theories of the vacuum must be changed. The implications for either experimental result will be significant.

Generating "Subcosmic Rays" In A Cold Vacuum Chamber

Calculations by Rueda (1978), Cole (1995) and Rueda, Haisch and Cole (1995), indicate that in a very empty region of space with few particles and weak magnetic fields, the vacuum fluctuations will randomly push charged particles to higher and higher speeds until they approach the speed of light. This might be the cause for cosmic rays. According to Haisch, there is a quite large effect on protons, of the order of 1000 eV increase in energy per second. This level of energy is much greater than the thermal energy of a gas of 312 kT (0.04 eV at $T=300$ K), and larger than any stray "patch" voltages that may exist in a piece of experimental apparatus.

It might be possible to set up a very empty, very cold vacuum chamber, with a single charged particle in it, and monitor the velocity of the charged particle with time to see if it is accelerated. Haisch has suggested that instead of a proton, that an antiproton be used. This suggestion has many advantages

over attempting to use any other particle. Since the theory gives a definitive prediction for a proton, the result should be the same for an antiproton. A single antiproton can be trapped, cooled to millikelvin temperatures, and its presence and initial position in the trap confirmed before the trap voltages are turned off. A sealed cryogenically cooled trap has essentially no residual air molecules in it. This has been proven by keeping 100,000 antiprotons in a trap for over a month without losing any since an annihilation of an antiproton by a nucleus would have produced easily detectable gamma rays or high energy pions. The traps can be made with a large working area along the axial direction. The antiproton can be "dropped" from essentially zero starting velocity and let fall a number of centimeters. Longer "drop" times can be obtained using a drop tower.

When the antiproton finally strikes the wall of the trap, it will annihilate with the wall nuclei. The annihilation produces 2-6 gamma rays and 3-7 high energy pions, all of which are easily detected by a surrounding complex of radiation detectors. The pion tracks and the gamma ray events can be triangulated back to determine the annihilation point to a mm or so, so the exact time and place of the annihilation event can be determined.

The experiment would then be repeated a number of times until a pattern of annihilation events is obtained. If the pattern is concentrated at the trap bottom, then only gravity accelerations are involved. If the pattern is concentrated at a few spots on the trap walls, then there are "work function patches" on the walls that are attracting the antiprotons to the patches by their electrical potential. If however, the pattern is random in space and very short in time, then this is good evidence that the vacuum electromagnetic fluctuations are the acceleration mechanism. One important aspect of this experiment, is that if the acceleration mechanism is found to operate, then this demonstrates at least one mechanism for the continuous

"Inertia Wind" Experiment

According to unpublished studies by Puthoff, accelerating and decelerating inertial masses interact with the surrounding vacuum fluctuation field and create an "inertia wind" that propagates out through the vacuum. If a test mass is placed near the source, the outspreading inertia wind will interact with the test mass, pushing or pulling it, and causing it to respond. Puthoff originally calculated that a pair of 40 kg source masses rotating in a 1 meter radius circle at about 20 rpm can create an attractive or repulsive inertia wind force on a test mass comparable in amplitude to the attractive Newtonian gravitation force of the source masses. Puthoff has built some apparatus and is presently conducting experiments. The output of his sensing apparatus is presently dominated by large noise signals, such as ground noise and magnetic coupling to the rotating steel beam holding the generating masses.

There is yet no publication which describes the experimental apparatus and which outlines in mathematical detail the physical model used to predict the experimental result. Such information that exists can be obtained by contacting Puthoff directly.

Although Puthoff feels that the "inertia wind" theoretical model he is using to design the experiment and predict the experimental results is a straightforward extrapolation of the theory in the paper by Haisch, Rueda, and Puthoff (1994), his coauthors on the original paper are skeptical of the predicted magnitude, and Puthoff is now reworking the calculations to obtain a more definitive prediction. Rueda, in particular, feels that any "wave" generated by an accelerating mass would stay attached to the mass as a "solitonic type" wave, and would not create an "inertia wind" to detect.

The reason this experiment is placed low on the priority list is that Puthoff's colleagues on his theoretical paper do not agree with Puthoff's inertia wind theoretical extension of their joint paper. Thus, this experiment fails the criteria that a null result will disprove the theory.

It would seem to me, that a force this large would have been noticed before, especially during gravity antenna calibration experiments carried out by Forward and Miller [J. App. Phys. 38, 512-518 (1967)] using rotating masses and Sinsky [Ph.D. Thesis, University of Maryland (1967)]¹ using vibrating masses. These experiments should be reanalyzed using the Puthoff "inertia wind" model to see if the "inertia wind" effect should have been seen in those papers. Puthoff and Little are presently analyzing the Forward paper.

Also, according to Puthoff, rapidly rotating gyroscopes should produce an inertia wind. This should lead to measurable forces and torques of one gyroscope on another. It would seem that these forces would have easily been seen by now, especially if torques are generated, since the gyroscopes on precision inertial platforms are fairly close to each other. Again, calculations need to be done.

Nonlinearity Of Vacuum Experiments

In the paper, "Nonlinear Magneto-Optics of Vacuum: Second-Harmonic Generation," Ding and Kaplan (1989) proposed to generate second-harmonic "doubled" photons by focusing intense pulsed laser light on a region of the vacuum that had a strong magnetic field in it. According to classical electromagnetic theory, the electromagnetic field is completely linear, so there should be no interaction between the laser photons and the magnetic field. But if the fluctuations of the vacuum are taken into account, then the virtual positron-electron particle pairs created by the fluctuations result in a polarizable "plasma" in the region that can provide the nonlinear coupling mechanism needed to generate the second-harmonic photons.

This experiment is important since it can distinguish between two existing physical models for the vacuum. In the standard quantum mechanical model, not only do atoms in matter undergo residual vibrational fluctuations even at zero absolute temperature, but the vacuum itself contains residual electromagnetic fluctuations. In the alternative "Fluctuating Charged Particle

Source Field Theory model, it is assumed that although atoms undergo residual vibrational fluctuations, there are no electromagnetic fluctuations of the vacuum and especially, there are no charged-particle positron-electron pairs being created in the vacuum. All the effects that occur in this model are produced by the vibrational fluctuations of the charged particle "sources" in the apparatus creating electromagnetic fields that pass through the vacuum to the other charged particles in the apparatus, causing them to vibrate in phase with the "source" particles. This "in-phase" sympathetic vibration produces forces which produce the experimental results.

The interaction region in the proposed experiment by Ding and Kaplan will contain only laser light, magnetic fields, and vacuum. It will contain no charges, no polarizable particles, and no conductors, so there is no mechanism to explain a successful experimental result from the fluctuating chargedparticle source field point of view-unless one cannot ignore the currents in the source of the magnetic field, even though that source is distant from the interaction region. A positive result from the experiment of the right magnitude would "prove" that the vacuum itself contains quantum fluctuations of the electromagnetic field. A null result from the experiment would "prove" that the fluctuation charged-particle source field model is the more "correct" model, and the idea that the vacuum itself has fluctuations is not a correct physical picture.

This experiment would be difficult to do, since it requires high laser intensities and high magnetic fields at the same time. The field intensities required to produce a detectable number of doubled photons were recently re-estimated by Kaplan and Ding (1995) to be 1022 W/cm² of pulsed laser flux focused on a 1000 T pulsed magnetic field. These required laser intensities are far beyond those projected to be available in the near future, so this experiment is not recommended for consideration at the present time.

There is an alternate way to do the experiment. Instead of concentrating a large number of laser photons of moderate photon energy into a small region to obtain the required high photon energy density, the energy of the individual photons can be increased so as to obtain the required high energy density with fewer photons. An Italian group (Bakalov, et al. 1994) has proposed an experiment using a 9 T magnetic field and high energy photons produced by a particle accelerator rather than a laser. A successful measurement would amount to a direct observation of the "polarization" of the vacuum produced by

the production of charged-particle positron-electron pairs in the vacuum. This experiment is being funded as part of the Italian high energy physics program.

Making And Weighing Casimatter

Alan M. Schwartz has recently proposed over the Internet that it might be possible to physically "weigh" the Casimir energy in a multigram sample of "Casimatter," composed of thousands of layers of 80 nm thick aluminum alternating with 50 nm thick magnesium fluoride (MgF₂), which is a good dielectric that is easy to deposit. The Casimir energy generated between the conducting aluminum plates would make a finite (negative) contribution to the energy and thereby the mass of the Casimatter sample. He proposes weighing the sample of Casimatter, heating the Casimatter to destroy the layer separation, thus eliminating the Casimir energy contribution and turning the Casimatter into ordinary matter, then weighing it again. His internet message did not go into great detail and did not give an estimate of the size of the effect to be expected. It is, however, relatively easy to take his idea, push it to the extreme, and see if the maximum calculated mass difference is within the reach of possible future measurement techniques, and thus is a possible candidate for a mass modification experiment.

Aluminum has a reflectance of 90% at a wavelength of $\lambda=120$ nm/cycle [AIP Handbook, 3rd Ed. (1972), Table 6g-1, page 6-124] and drops after that, but there is no handbook information what the cutoff wavelength is. (Elsewhere in this report, on page 15, I estimate it at $\lambda=60$ nm/cycle.) The minimum thickness of aluminum film needed to give that high 90% reflectance is about 40 nm [AIP Handbook, 3rd Ed. (1972), Table 6g4, p. 6159], although the reflectance of a thin aluminum film is still 87% at 30 nm thickness and 76% at 20 nm thickness, so thinner films can be considered if desired.

I will assume (as I did on page 15), that the appropriate Casimir plate spacing L for a given cutoff wavelength is not the wavelength ($L=\lambda$), or half the wavelength ($L=\lambda/2$), but instead the reduced wavelength given by $L=\lambda/2$. [This assumption needs to be verified by a competent theorist, and if not correct, then the following analysis needs to be revised with new numbers.]

Given the above, let us consider an extreme version of Casimatter, consisting solely of a very large number of very thin aluminum film layers at very close spacings. I will make the conservative assumption that the reflectance cutoff wavelength for aluminum is $\lambda=120$ nm/cycle (90% reflecting), which means that we can consider a spacing between the aluminum plates in the Casimatter of $L=\lambda/2$ ($=60$ nm), and the thickness of the aluminum films as 40 nm. To simplify things, I will assume that the 60 nm spacing between the aluminum films will be filled with an ideal dielectric with index of refraction 1 and density 1 g/cc.

The Casimir formula for the energy per unit area between conducting plates of area A and spacing L is:

$$u = U/A = - \frac{\pi^2 \hbar c}{1440 L^3}$$

where $\hbar = 6.63 \times 10^{-34}$ J.s and $c = 300$ Mmis. From this, it is easy to calculate the energy density e in the volume between two of the plate pairs of area A and separation L that make up one of the layers.

$$e = u/L = - \frac{U}{LA} = - \frac{\pi^2 \hbar c}{1440 L^4}$$

For a spacing of $L = 20$ nm, the (negative) energy density is -2.7 kJ/m³ or -2.7 mJ/cc. This energy density gives the vacuum a relativistic mass density ρ , of:

$$\rho_v = e/c^2 = - \frac{\pi^2 \hbar}{1440 c L^4}$$

which for a layer spacing of $L = 20$ nm results in a negative mass density for the vacuum of -3.0×10^{-14} kg/m³ or -3.0×10^{-17} g/cc.

If we assume the thickness of the aluminum plates to be $T = 40$ nm and the separation between the plates to be $L = 20$ nm. then 2/3rds of the volume will be aluminum with density 2.7 g/cc and 1/3rd will be the ideal dielectric with density 1 g/cc, for an average density of the matter in the Casimatter of 2.23 g/cc. The 1/3rd containing the dielectric will also contain the negative Casimir mass density of -3.0×10^{-17} g/cc, for an average density of the vacuum energy in the Casimatter of 1.0×10^{-17} g/cc.

For an experiment, we would want to fabricate about a cubic centimeter of Casimatter, probably in the form of a plate in cm by 10 cm by 0.01 cm thick. Since the thickness of a layer pair is 40 nm of aluminum followed by 20 nm of dielectric, or 60 nm overall, there would be 1667 layer pairs, not that difficult to fabricate. The real question would be whether it is possible to measure a sample and its container vial massing a few grams to an accuracy of 10^{-17} g or better. Right now, I can't think of a way to do it, since the force levels are beyond the present capabilities of available atomic force microscopes and the accuracy required for a frequency measurement is beyond the capabilities of available clocks.

People thinking about working on this idea should appreciate that the energy density levels involved are smaller than chemical energies and an experiment must include accurate calorimetry. For example, since aluminum

has a specific heat of about $0.9 \text{ J/K}\cdot\text{S}$, in order to measure the estimated Casimir energy density of the Casimatter of 2.7 mJ/cc , a 1 cc sample would have to be temperature controlled to better than a millikelvin, and the heat flow into or out of the sample would have to be known to better than a millijoule. In fact, a useful first experiment would be to fabricate some Casimatter and measure how much it cools off as the negative Casimir energy in the Casimatter is eliminated by destroying the internal structure. This thermal-type experiment would show that the Casimir effect produces measurable negative energy, but it would not give any definitive experimental evidence for a mass modification effect.

Annotated Condensed Bibliography

This bibliography is not complete. It merely contains the more important papers that I used in writing this report.

AmbjBm, Jan and Stephen Wolfram, "Properties of the Vacuum. 1. Mechanical and Thermodynamic, *Annals Physics* 147, 1 32 (1983) paper derives Casimir energy per unit volume for conducting rectangular boxes. Cubes have positive energy and repulsive forces on the walls, long rectangles or parallel plates have negative energy and attractive forces on the walls. See especially Fig. 4.2 on page 16. Be careful in using this paper since the calculations are for many different types of fields--scalar, vector. etc, and many different boundary conditions. Make sure you get the right one for the electromagnetic field and electromagnetic boundary conditions. See also Hacyan (1993.)

Arnold, W., S, Hunklinger, and K. Dransfeld, "influence of optical absorption on the van der Waals interaction between solids," *Physical Review B* 19, 6049-6056 (1979): Erratum, *Physical Review* 821, 1713 (1980).[Last measurement of the Casimir force (15 years ago!). Crystalline quartz, borosilicate glass, and silicon. Good agreement with data, but the experiments only ranged from 80 to 1000 nm and didn't get very far into the $1/L3$ unretarded region. The Casimir force between two silicon surfaces increased when the silicon was illuminated. However, silicon seemed to behave differently than expected at close distances. Reason for difference not known.]

Bakalov, D., et al., "PVLAS - Vacuum Birefringence and Production and Detection of Nearly Massless, Weakly Coupled Particles by Optical Techniques," *Nuclear Physics B* S35, 180-182 (1994). [PVLAS is an experiment designed to measure the vacuum magnetic birefringence. It is based on a very sensitive ellipsometer and a 9 T superconducting dipole magnetic. See also Cantatore (1991).]

Barton, G., "Faster-than-c light between parallel mirrors: the Scharnhorst effect rederived," *Physics Letters* 8237, 559-562 (1990). [Rederives the Scharnhorst effect from another viewpoint and ends up agreeing with Scharnhorst. See also Milonni and Svozil (1990).]

Barton, G. and K. Scharnhorst, "OED between parallel mirrors: light signals faster than c , or amplified by the vacuum, *J. Physics A*26, 2037-2046 (1993). [Either the high-frequency index of refraction of the vacuum between parallel mirrors is less than one, indicating that light travels faster than c , or at some range of the higher frequencies, the imaginary part of the index of refraction becomes negative, which means that the vacuum is an amplifier of light.)]

Bennett, Gary L., Robert L. Forward, and Robert H. Frisbee, "Report on the NASA/JPL Workshop on Advanced Quantum Relativity Theory Propulsion," AIAA Paper 95-2599, 31st AIAA/ASME/SAE/qSG Joint Propulsion Conference, San Diego, CA (July 1995). [See page 10 for discussion of the Scharnhorst effect.]

Black, W., J.G.V. de Jongh, J.T.G. Overbeek, and M.J. Sparnaay, "Measurements of retarded van der Waals' forces," *Trans. Faraday Society* 56, 1597-1608 (1960). [Measured $1/L^4$ force for two flat glass plates and $1/L^3$ force for flat plate and spherical surface. Data full of scatter. Lots of information on experimental techniques and problems that must be avoided. This paper supersedes previous papers by Sparnaay, 1957 and 1958, and Overbeek and Sparnaay, 1954.]

Boyer, T.H., "Equilibrium distributions for relativistic free particles in thermal radiation within classical electrodynamics, *Physical Review* A20, 1246-1259 (1979). (Calculates that free charges acted on by zeropoint radiation will randomly diffuse to higher and higher velocities. Used by Cole (1995) and Rueda, Haisch and Cole (1995) for their astrophysical papers.)]

Cantatore, G., F. Dellavalle, E. Milotti, L. Dabrowski, and C. Rizzo, "Proposed Measurement of the Vacuum Birefringence Induced by a Magnetic Field on High Energy Photons," *Physics Letters* 8265, 418-424 (1991). [Proposes an experimental set-up to observe and measure the interaction between high energy photons and a strong magnetic field. The successful measurement of such an effect would amount to a direct observation of QED vacuum polarization. See also Bakalov (1994).]

Carlip, S., "Comment on 'Gravity as a zero-point-fluctuation force'," *Physical Review* A47, 3452-3453 (1993). [Puthoff's reply follows. Carlip says that Puthoff did his calculations wrong and Puthoff replies that Carlip did them right.)]

Casimir, H.B.G., "On the attraction between two perfectly conducting plates," *Proceeding Koninklijke Nederlandse Akademie van*

Wetenschappen, Amsterdam 51, No. 7, 793-796 (1948) [in English]. [The paper that started it all. It is an extrapolation of the more detailed paper, Casimir and Polder (1948).]

Casimir, H.B.G, and D. Polder, "The influence of retardation on the London-van der Waals forces, *Physical Review* 73, 360-372 (1948). [Applies retardation to the London-van der Waals calculations of the attraction between a neutral atom to a wall and two neutral atoms. London and van der Waals got $1/R^3$ and $1/R^6$ (which didn't agree with experiment). Retardation makes the forces drop off as $1/R^4$ and $1/R^7$. The "correction factor" had Planck's constant in it, indicating the extra factor of $1/R$ had something to do with quantum theory. Casimir then wrote his paper (1948) on the attraction between two conducting plates.)

Cole, Daniel C., "Possible thermodynamic law violations and astrophysical issues for secular acceleration of electrodynamic particles in the vacuum," *Physical Review E* 51, 1663-1674 (1995). [See Rueda (1978). Boyer (1979) and Rueda, Haisch and Cole (1995). Tries to explain away the thermodynamic problems associated with the unrestrained growth of the speed of charged particles driven by vacuum fluctuations.]

Deriagin, B.V. and I.I. Abrikosova, "Direct measurements of molecular attraction of solids," *J. Phys. C-PPL: Solids* 5, 1-10 (1958). [A summary of previous data on quartz surfaces, glass surfaces, and calcite-quartz, using a spherical surface against a flat surface. Good deal of information about experimental procedures to get rid of electrical patch effects and dust.]

Ding, Y.J. and A.E. Kaplan, "Nonlinear Magneto-Optics of Vacuum: Second-Harmonic Generation, *Physical Review Letters* 63, 2725-2728 (18 December 1989). [Predicts that a high power laser beam focused at a strong magnetic field will produce second-harmonic photons due to the nonlinearity of the photon-photon scattering in the vacuum. Milonni agrees that if not successful, then this shows that the vacuum itself has no fluctuations and the source model is a more correct physical model of the vacuum. The power required was increased substantially in the recent paper by Kaplan and Ding (1995).]

Drever, R.W.P., "A search for anisotropy of inertial mass using a free precession technique, *Philosophical Magazine* 6, 683-687 (1961). [Experiment done to test Mach's Principle of inertia. Can detect anisotropy of inertial mass to 5×10^{-23}]

Forward, Robert L., "Extracting electrical energy from the vacuum by cohesion of charged foliated conductors." *Physical Review B* 29, 1700-1702 (15 August 1984). [Proposes to convert the "surface energy" of a foliated conductor into electrical energy by cohering the leaves of the foliated

conductor into a solid block (with less surface energy) under the control of a bidirectional power supply that extracts energy in the form of electricity. Does not violate energy conservation laws.]

Hacyan, S., R. Jauregul and C. Villarreal, "Spectrum of quantum electromagnetic fluctuations in rectangular cavities, *Physical Review A* 47, 4204-4211 (1993). [Calculates Casimir energy and pressure in rectangular cavities. Agrees in general with Ambjerm and Wolf ram (1983), but finds slight differences. See Fig. 1.]

Haisch, Bernhard, Alfonso Rueda, and H.E. Puthoff, "inertia as a zero-point-field Lorentz force", *Physical Review A* 49, 678-694 (1994). (One of the two papers that initiated the study. States that the inertia of a body is caused by the fluctuations of the vacuum. No objections to this paper have been published yet.)

Hawton, Margaret. "One-photon operators and the role of vacuum fluctuations in the Casimir force," *Physical Review A* 50, 1057-1061 (1994). [Proposes that spontaneous emission and the Casimir force can be explained by creation of single photons at the positions of charged particles]

Hessels, E.A., P.W. Arcuni, F.J. Deck, and S.R. Lundeen, "Microwave spectroscopy of high-L, $n=10$ Rydberg states of helium, *Physical Review A* 46, 2622-2641 (1992). [Long, detailed experimental paper. Although the electron and the rest of the helium atom is charged, so that electric forces are dominant, the Casimir-Polder retarded forces must be included in the theory to get the right result. For example, the separation between the 10G and 10H levels is 491,005.2 kHz, while the theory predicts 491,007.5 kHz, of which 42.2 kHz is the retardation effect. The residual of 2.27 ± 0.5 kHz (5 sigma) is not understood.]

Hunklinger, S., H. Gersselmann, and W. Arnold, "A dynamic method for measuring the van der Waals forces between macroscopic bodies. *Rev. Sci. Instruments* 43, 584-587 (1972). (Reasonably accurate measurement of $1/L^4$ law at distances of 80 to 800 nm. Uses speaker cone modulation of one plate to measure the derivative of the Casimir force as a function of separation distance.)

Iacopini, E., "Casimir effect at macroscopic distances," *Physical Review A* 48, 129-131 (1993). r lc-Casimir force on the mirrors will be periodic using confocal mirror resonator structure to Casimir force at a few centimeters. Predicts with change in mirror separation. I don't think the analysis has been done carefully enough. Needs to be verified by a good vacuum theorist.]

Israelachvili, J.N. and D. Tabor. "Measurement of van der Waals dispersion forces in the range 1.5 to 130 nm," *Proc. Roy. Soc. A* 331, 19-38 (1972). [Very good experimental results showing both $1/L^4$ and $1/L^3$ laws.

Done with mica cylinders rather than metal plates. Supersedes Tabor and Winterton, 1969.]

Kaplan, A.E. and Y.J. Ding, "Field-Gradient-Induced Second Harmonic Generation in Magnetized Vacuum. [Submitted to JOSA B (1995). New calculations increase the estimated laser power required to 1022 W/cm² from the estimated power of 1014 W/cm² in their previous paper by Ding and Kaplan (1989).]

Kitchener, J.A. and A.P. Presser, "Direct measurement of the long-range van der Waals forces", Proc. Royal Soc. A242, 403-409 (1957). (Reasonably good measurement of 1/L⁴ law. Experimental technique shows that "mosaic" charges on the plates are a problem error source.]

Latorre, Jose, Pedro Pascual and Rolf Tarrach, "Speed of light in non-trivial vacua," Nuclear Physics 8437, 60-82 (1995). [Interesting paper that shows that the speed of light in vacuum is given by a very general formula $c/c_0 = 1 - 44a^2\pi^{1/3}m^4/p$, where a is the fine structure constant, m is the mass of the electron, and p is the energy density of the field being considered. This seems to hold for electric, magnetic, gravitational, temperature, and Casimir fields, including the mysterious factor of 11. If the energy density p is negative, as it is in the gravitational and Casimir field cases, then the speed of light is faster than c_0]

Levi, Barbara Goss (editorial summary), "New evidence confirms old predictions of retarded forces," Physics Today, 18(April 1993). [Readable summary of what was going on in the field of long range interatomic forces as of 1993.]

Lifshitz, E.M., "The theory of molecular attractive forces between solids," Soviet Physics JETP 2, 73-83 (1956) [Zh. Eksp. Teor. Fiz 29, 94 (1955)1. [Good theoretical paper deriving the Casimir force for dielectrics instead of conductors.]

Milonni, P.W., "Casimir forces without the vacuum radiation field," Physical Review A25, 1315-1327 (1982). [One of many papers by Milonni showing that there are two alternative physical models for the various Casimir effects--vacuum fluctuation fields and charged particle source fields. This paper calculates the Casimir-Polder attraction of a neutral atom and a plate, and the van der Waals force between two neutral atoms.]

Milonni, Peter W., The Quantum Vacuum: An Introduction to Quantum Electronics, Academic Press, New York (1994). (Book containing highly mathematical discussion of many quantum vacuum fluctuation phenomena including a number of experiments. Very good on the "history" of the field, but not an easy read for experimentally oriented types.]

Milonni, P.W. and M.-L. Shih, "Source theory of the Casimir force," Physical Review A45, 4241-71 (1992). [A more recent paper that does the

calculation for the Casimir force between plates using many different physical models. This paper intimates that it might be possible to modify or modulate the van der Waals interaction by spatially coherent laser radiation.]

Milonni, Peter W., and Karl Svozil, "impossibility of measuring faster-than-c signaling by the Scharnhorst effect," *Physics Letters* 8248, 437-438 (1990). [Calculates that quantum uncertainties in turning on an electromagnetic signal will create errors in timing larger than the time difference created by the signal propagating "Faster-thanlight." It is not that Scharnhorst is wrong, it is just that a simple propagation time measurement will not lead to a violation of causality because of basic quantum uncertainties.]

Milton, Kimball A., Lester L. DeRaad, Jr., and Julian Schwinger, "Casimir Self-Stress on a Perfectly Conducting Spherical Shell," *Annals Physics* 115, 388-403 (1978). [Recalculates the repulsive stress on a sphere to higher accuracy.]

Mostepanenko, V.M. and N.N. Trunov. "The Casimir effect and its applications," *Soviet Physics Usp.* 31, 965-987 (1988) [*Usp. Fiz. Nauk* 156, 385-426 (1988), in Russian.]. [General review paper of the Casimir effect. Authors make the point on page 980 that the Casimir-force experiments shows the physical reality of the fluctuations of the electromagnetic fields in the vacuum, while the Lamb-Retherford experiments show the physical reality of the fluctuations of the virtual particles (positron-electron pairs) in the vacuum.]

Onofrio, Roberto and Giovanni Carugno, "Detecting Casimir forces using a tunneling electromechanical transducer," *Physics Letters A* 198, 365-370 (1995). [Authors mention on page 369 that the gravity force of the Casimir disks are larger than the Casimir forces.]

Puthoff, H.E., "Gravity as a zero-point-fluctuation force," *Physical Review* A39, 2333-2342 (1989). [One of the two papers that started this study effort. Takes an idea by Sakharov and puts some mathematical flesh on it. The major problem with the paper is the assumption that ALL matter is made up of charged point-mass particles, such as electrons and quarks. This is nearly true, but electromagnetic fields and gluons do contribute to the gravity of an object, but they are not made of charged point-mass particles.)

Rueda, A., "Model of Einstein and Hopf for Protons in Zero-Point Field and Cosmic-Ray Spectrum," *Il Nuovo Cimento* 48A, 155-183 (1978). [It is proposed that the acceleration of cosmic-ray protons is caused by the zero-point electromagnetic fluctuations of the vacuum.]

Rueda, Alfonso, Bernhard Haisch, and Daniel C. Cole, "Vacuum zero-point field pressure instability in astrophysical plasmas and the formation of cosmic voids," *Astrophysical J.* 445, 716 (1995). [Amplifies what is said in Rueda (1978), Boyer (1979) and Cole (1995). The fluctuations of the vacuum in empty space will accelerate charged particles in regions of space of low

density and low magnetic fields until the particles become very high energy cosmic rays.]

Sassaroli, E., Y.N. Srivastava, and A. Widom, "Photon production by the dynamical Casimir effect," *Physical Review A* 50, 1027-1034 (1994). [See also Srivastava, Widom, and Friedman (1985). They show that it is possible to create intense photon radiation when two conducting plates are modulated periodically. Widom reports they are planning on doing experiments to look for this effect.]

Scharnhorst, K., "On propagation of light in the vacuum between plates," *Physics Letters* 8236, 354-359 (1990). [Calculates that the velocity of light between two Casimir plates is anisotropic, with the velocity of light perpendicular to the plates being greater than the velocity of light in unconfined space. See Barton (1990), Barton and Scharnhorst (1993), and Milonni and Svozil (1990).] -K. Scharnhorst wishes to point out that Eq. (26) in this paper should read $\sim c/c-1.5 \times 10^{-56} a^4$.

Sen, Dev. "Casimir force measurement between two goldplated quartz flats at large separations," oral paper at meeting of the APS Division of Atomic, Molecular, and Optical Physics, Toronto, Canada (15-19 May 1995). [Viewgraph copies only. No paper] was prepared. The only ongoing experiment attempting to measure the Casimir force between conducting plates. Dev Sen is doing the experiment as an undergraduate honors project at the University of Washington under the supervision of Prof. Steve K. Lamoreaux. He has recently achieved a plate separation of 8 μ m during setup, but still has a long way to go before starting to take data.]

Serry, F Michael, Dirk Walliser, and G. Jordan Mackay, "The anharmonic Casimir oscillator (AGO): The Casimir effect in a model microelectromechanical system," *IEEE/ASME J- Microelectromechanical Structures* (Dec 1995). [Analysis of a microelectromechanical structure that should oscillate about an equilibrium between the Casimir force and the force of a spring, and a voltage activated mechanical "switch" that uses the Casimir force to hold the switch closed. The group plans on fabricating the structures analyzed.]

Sldes, J.A., et al., "Magnetic resonance force microscopy," *Review of Modern Physics* 67, 249-265 (1995). (Reviews a possible method for measuring a small force on a small body. Basically an atomic force microscope modified to measure nuclear magnetic moments by measuring the force on the sample.)

Spamaay, M.J.. "Measurements of Attractive Forces Between Flat Plates," *Physica* 24, 751-764 (1958). [Last measurement made of Casimir force between metal plates. Data poor in quality. Chromium-steel and chromium plates produced attractive forces, but all author could say was, "The observed attractions do not contradict Casimir's theoretical prediction." Was not able to

measure forces between aluminum plates. Often got repulsion (probably due to dust or oxide) instead of attraction.)

Srlvastava, Y., A. Wldom, and M.H. Friedman, "Microchips as precision quantum-electrodynamic probes, Physical Review Letters, 55, 2246-2248 (1985). [Calculates that the QED fluctuations for present metal-oxide-semiconductor field-effect transistors is typically 0.1 of the electrostatic energy. See also Sassaroli. Srivastava and Widom (1994).]

Sukenlk, C.I., M.G. Boshler, D. Cho, V. Sandoghdar and E.A. Hinds. "Measurement of the Casimir-Polder Force," Physical Review Letters 70, 560-563 (1993). [Fairly convincing measurement of attraction of a neutral, unexcited sodium atom to a conducting wall, showing retardation must be taken into account.]

Short List Of Active Researchers In Vacuum Fluctuations

Barton, Gabrlel Physics and Astronomy Division University of Sussex, Brighton BN1 9QH, England, UR G.Barton@sussex.ac.uk Theoretical work on many aspects of vacuum fluctuation, including the problem of the superluminal speed of light between Casimir plates.

Boyer, Timothy H. Department of Physics The City College of the City University of New York Convent Avenue at 138th Street New York, New York 10031 USA boyer@sci.cuny.cuny.edu Many theoretical papers on vacuum fluctuations.

Braginsky, Vladmlr B. Moscow State University, Moscow 119899, Russia brag@mol.phys.msu.su Coauthor with F.Ya. Khalili on vacuum fluctuation "friction" and "damping." Usually works on gravitational radiation antennas and "quantum non-demolition" measurement techniques.

Cantatore, G. Dipartimento Fisica, Univ. Trieste, 1-34127 Trieste, Italy Papers on interaction of high energy photons with a magnetic field.

Carugno,Glovannl Institute Nazionale di Fisica Nucleare Sezione di Padova, 35131 Padua Italy Paper with Roberto Onofrio on detecting casimir forces using a tunneling electromechanical transducer Paper on interaction of high energy photons with a magnetic field.

Cole, Danlel C. IBM Corporation, Essex Junction, VT 05452 USA dan cole@vnet.ibm.com Go-author with Haisch and Rueda on cosmic void ZPF particle acceleration paper.

Ding, Yujie (Y.J.) Department of Physics and Astronomy Bowling Green State University 104 Overman Hall Ridge Street, Bowling Green, OH 43403 USA yding@andy.bgsu.edu Go-author of papers on nonlinear magneto-optics of vacuum with A.E. Kaplan.

Drever, Ron Physics Department, California Institute of Technology Pasadena, CA 91125 USA rond@tapir.caltech.edu Measured anisotropy of inertia to 5×10^{-23} in 1961 paper. Now running CalTech portion of LIGO (Laser Interferometer Gravitational Observatory).

Eberlein, Claudia Newnham College, Sidgewick Ave. Cambridge, CB3 9DF England, UK claudia@cromwell-physics.uic.edu Papers on theory of sonoluminescence being due to the Unruh effect.

Forward, Robert L. Forward Unlimited, P.O. Box 2783, Malibu, CA 90265 USA forward@whidbey.com Paper on extracting electrical energy from the vacuum. Conducted contract studies of vacuum fluctuation phenomena for the U.S. Air Force and NASA/JPL.

Haisch, Dr. Bernhard Lockheed Solar and Astrophysics Laboratory Div. 9130, Bldg. 252, Lockheed Pale Alto Research Lab. 3251 Hanover St., Pale Alto, CA 94304 USA haisch@sag.space.lockheed.com Coauthor with Puthoff and Rueda on vacuum fluctuations being the source of inertial mass. High energy physicist and Associate Editor, The Astrophysical Journal.

Hawton, Margaret Department of Physics, Lakehead University Thunder Bay, Ontario, Canada P7B 5E1 mhawton@gale.lakeheadu.ca Papers on source fluctuations causing effects rather than vacuum fluctuations. Doesn't believe in vacuum fluctuations.

Hinds, E.A. Physics Department, Yale University POB 6666, New Haven, CT 06520 USA Paper on measurement of the Casimir-Polder force with ground state sodium atoms between plates with G.I. Sukenik, M.G. Goshier, D. Cho, and V. Sandoghdar.

Iacopini, E. Dipartimento di Fisica dell'Università di Firenze Florence, Italy Proposed experiment to use confocal mirrors as Casimir plates to measure the Casimir force at centimeter distances.

Kaplan, Alexander A., Prof. Dept. Electrical and Computer Engineering, The Johns Hopkins University, 3400 N. Charles Street, Baltimore, MD 21218 USA sasha@super.ece.jhu.edu hnp:il.psi.ece.jhu.edu ui-kaplan Go-author of papers on non-linear magneto-optics of the vacuum with Yujie Dins.

Lamoreaux, Steve K. Physics Department, Bldg. F-15 University of Washington, Seattle, WA 98195 USA lamore@galileo.phys.washington.edu Faculty adviser to Dev Sen on experiment to measure the Casimir force between two gold-plated quartz flats at large distances.

Latorre, Jose L. Departament d'Estructura i Constituents de la Materia Facultat de Física, Universitat de Barcelona Diagonal 647, 08028 Barcelona, Spain latorre@ecm.ub.es Wrote 1995 paper calculating the speed of light for a different "non-trivial vacua" with Pedro Pascual (pascual@ecm.ub.es) and Rolf Tarrach (rolf@ecm.ub.es)

Maclay, G. Jordan Department of Electrical Engineering and Computer Science University of Illinois at Chicago MIC 154, P.O. Box 4348, Chicago, IL 60680 USA He and students are looking at measuring and using Gasimir forces in microelectromechanical structures.

Mead, Franklin B., Jr. PVRRF Air Force Phillips Laboratory, Edwards fLF CA 93524-7680 USA Has filed patent on extracting energy from the vacuum.

Milonnr, Peter W. Theoretical Division, LANL, Los Alamos, NM 87545 USA pwm@t4.lanl.gov Many papers showing that effects attributed to vacuum fluctuations can be explained by correlated quantum fluctuations of the source charges in the experimental apparatus.

Onotrio, Roberto Dipartimento di Fisica, Universita di Padova Via Marzolo 8, 35131 Padua Italy onofrio%38619.hepnet@csa4.LBL.gov Paper with Giovanni Garugno on detecting Gasimir forces using a tunneling electromechanical transducer Paper with Bakalov on interaction of high energy photons with a magnetic field. Has also worked on quantum non-demolition measurement techniques.

Puthon, Hal E. Institute for Advanced Studies at Austin 4030 Braker Lane W., Suite 300, Austit, TX 78759 USA puthoff@aol.com The person that started all this by saying that gravity and inertia are caused by vacuum fluctuations.

Rueda, Alfonso Dept. Electrical Engineering, ECS-518 California State University at Long Beach 1250 Bellflower Blvd, Long Beach, CA 90840-8303 arueda@csulb.edu Many papers on vacuum fluctuations. Go-author with Puthoff and Haisch on vacuum fluctuations being the source of inertial mass.

Scharnhorst, Klaus Department of Physics, University of Wales Sw Singleton Park, Swansea SA2 8PP, Wales, UR T R.Scharnhorst@swansea.ac.uk Theorist, discovered the Scharnhorst effect, that the speed of light is greater than c perpendicular to Gasimir plates.

Schwartz, Alan M. (Uncle Al) Chief Technical Officer, Molecular Genesis Life Sciences LTD, Vancouver, BC, Canada Snailmail Address: 49 Fabriano, Irvine, CA 92720-2525 USA uncleanO@ix.netcom.com ("zero" before @) <http://www.com/adsinti/treehandluncleali> Suggested making and weighing "Gasimatter". Only publications on Gasimatter to date are on e-mail from Schwartz and in this report.

Sen, Dev Honors Undergraduate Student Physics Department, Univ. Washington, Seattle, WA 98195 USA Home: 1304 NE 42nd Ave. #209, Seattle, WA 98105 USA dsen@u.washington.edu Carrying out experiment on Casimir plates made of gold-plated quartz flats, trying to measure Casimir force at large distances.

Tarrach, Roll Departament d'Estructura i Constituents de la Materia Facultat de Ffsica, Universitat de Barcelona Diagonal 647, 08028 Barcelona, Spain rolf@ecm.ub.es Wrote 1995 paper calculating the speed of light for a

number of different "non-trivial vacua" with Pedro Pascual (pascual@scm.ub.es) and Jose Latorre (latorre@scm.ub.es)

Widom, Alien Physics Department, Northeastern University, Boston, MA02115 USAwidom@neu.edu Papers on microchips and vacuum radiation from moving conductors

INTERESTING READING LIST

BY ZACK WIDUP'S

I have put together a list of materials (books, papers etc.) that I have read over the last few years which I feel would assist in understanding free energy, non conventional physics, etc. I have arranged them in alphabetical order of authors.

Y. Aharonov and D. Bohm, "Significance of Electromagnetic Potentials in the Quantum Theory", Phys. Rev. Second Series, Vol. 115, No. 3, August 1, 1959, pp. 485-491

Thomas E. Bearden, THE EXCALIBUR BRIEFING

Thomas E. Bearden, NEW TESLA ELECTROMAGNETICS

Thomas E. Bearden, PART I: THE SOLUTION TO TESLA'S SECRETS AND THE SOVIET TESLA WEAPONS; PART II: REFERENCE ARTICLES FOR SOLUTIONS TO TESLA'S SECRETS

Thomas E. Bearden, TOWARD A NEW ELECTROMAGNETICS PART III: CLARIFYING THE VECTOR PRINCIPLE

Thomas E. Bearden, TOWARD A NEW ELECTROMAGNETICS PART IV: VECTORS AND MECHANISMS CLARIFIED

Thomas E. Bearden, THE FINAL SECRET OF FREE ENERGY

Thomas E. Bearden, CANCER AND THE UNRESOLVED HEALTH ISSUES IN THE BIOLOGICAL EFFECTS OF EM FIELDS AND RADIATION

Thomas E. Bearden, STAR WARS NOW! THE BOHM-AHARONOV EFFECT, SCALAR INTERFEROMETRY, AND SOVIET WEAPONIZATION

John Bedini, BEDINI'S FREE ENERGY GENERATOR

Sir Jagadis Chandra Bose, RESPONSE IN THE LIVING AND NON-LIVING

Sir Jagadis Chandra Bose, COLLECTED PHYSICAL PAPERS

Timothy H. Boyer, "Random electrodynamics: The theory of classical electrodynamics with classical electromagnetic zero-point radiation", Phys. Rev. D, Vol. 11, No. 4, 15 Feb. 1975, pp. 790-808

Hugh L. Everett III, THE MANY-WORLDS INTERPRETATION OF QUANTUM MECHANICS

Richard P. Feynman, THE FEYNMAN LECTURES ON PHYSICS

R. A. Ford, SPACE ENERGY RECEIVERS

Jack S. Greenberg and Walter Greiner, "Search for the Sparking of the Vacuum", Physics Today, August 1982, pp. 24-32

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A QUANTUM BROOM SWEEPS CLEAN

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Pity the astronomers and physicists. They toss and turn at night wondering why the universe is lumpy, and rack their brains trying to unify the four fundamental forces of nature. Now a new theory, which claims to solve both problems at once, will probably cost them more sleep.

The most fundamental equation in physics is the relation between force, mass, and acceleration which Isaac Newton postulated over three centuries ago: $F=ma$. It defines the concept of inertia, the resistance that an object puts up to a change in motion. To make something move faster or slower, you need to apply a force, and the force you need to apply is greater for larger masses. This is such a simple, intuitive fact that it seems more foolish than profound to ask, Why is it true? Why do objects have inertia?

As fundamental as this question is, a convincing answer has eluded the likes of Albert Einstein and Richard Feynman. Ideas about inertia have fallen into two schools. Newton himself argued it is an intrinsic property of matter, capable of no further explanation. To tell whether an object possesses inertia, you do not have to measure its motion with respect to external reference points; you need only look for the telltale distortions that occur whenever a body that has inertia accelerates. Rotation, for example, is one form of acceleration. As Earth rotates, its equator bulges out -- a dead giveaway that our planet possesses inertia.

Newton's idea of absolute acceleration, one that did not need external objects to define it, bothered many scientists -- among them the 19th-century Austrian physicist and philosopher Ernst Mach, whose ideas helped to inspire Einstein's theories of relativity. Mach argued that all motion is relative. If Earth were all alone in a hypothetical universe devoid of other matter, how would it know whether it was rotating? And if Earth did not know whether it was rotating,

how would its equator know whether to bulge out? Mach resolved this paradox by concluding that the solitary Earth could not have any inertia. Somehow, the Earth's inertia is generated by the presence of other matter in the universe.

But how? Einstein thought that his general theory of relativity would embody Mach's principle, but it turned out not to. The source of inertia remained a mystery until, we believe, 1994 -- when, together with Harold Puthoff of the Institute for Advanced Studies in Austin, Texas, we proposed a radical theory: that inertia is an electromagnetic force that switches on whenever an object accelerates through space. It turns out that Mach was almost right. In our theory, inertia does depend on an external frame of reference, but this frame of reference is provided not by the other bodies in the universe, but by an electromagnetic field that pervades the cosmos. This field, in turn, arises because of quantum mechanical ferment in the vacuum -- a subject shaping up as a major theme of 21st-century physics.

Last year, we realized that the vacuum also might explain another great mystery of modern science: how the universe, at the largest scales, came to look like a whiffle ball. The honeycombed arrangement of galaxy clusters may hold the key to understanding how inertia, gravity, and mass came to be.

Sponges and Swiss Cheese

Four years ago, the NASA Cosmic Background Explorer detected blemishes in the microwave afterglow of the Big Bang. Astronomers were relieved. It was the first evidence that the early universe was not perfectly smooth and uniform [see "New Image of the Universe Soon After Creation," May/June 1992, p. 91]. Perfect uniformity would have left no way for cosmologists to explain how the lumpy present-day universe could arise from utterly homogeneous primordial stuff. Yet the COBE discovery accounted for only the highest level of inhomogeneity, on scales of 1 to 2 billion light-years (see images on p. 13). The largest structures known today in the universe are 10 times smaller.

Those structures are the great voids and sheets. Astronomers have known for some time that galaxies are concentrated into enormous clusters, but in the past decade, observers have discovered that the clusters are themselves concentrated into vast sheets, or walls. In between the walls are giant voids almost free of galaxies (see diagram above). The size of the cosmic voids ranges from tens to hundreds of millions of light-years. On these scales, the universe looks like Swiss cheese or a sponge: more hole than substance [see "Mapping the Universe," May/June 1990, p. 66].

How did this superstructure come about? Gravitation can explain the clumping if you assume the universe had just the right mixture of ordinary matter, cold dark matter, and hot dark matter. But this leaves astronomers a bit

uneasy. After all, we do not know what the dark matter is or whether it could exist in the necessary amounts. The recent announcement that white dwarfs may comprise half the dark matter in our galaxy does not help, because the cosmological dark matter would have had to reside outside galaxies and consist of material entirely unlike ordinary atoms.

Under these circumstances, the prudent thing to do is to examine other possible explanations, to search for the dark horse in addition to the dark matter. Can we account for the structures without having to populate the universe with unknown kinds of matter?

Deep intergalactic space, where the large-scale structures began to form, is a cosmic desert. Out there, the density of gas is low, so low that gas particles are subject only to minute forces exerted by the vacuum that surrounds them. The word vacuum innocently implies "empty," but nothing in quantum mechanics is ever so straightforward. The vacuum of modern physics is far from empty -- quite the opposite. It is a seething soup of subatomic particles and energy fields bubbling in and out of existence, a cauldron where the very notions of "space" and "time" may take on their meaning.

The not-so-empty vacuum is a consequence of the fact -- recognized by German physicist Werner Heisenberg in 1927 -- that you can never remove all the energy from anything. Take an electromagnetic field. It consists of photons, individual packets of energy each in a state defined by its direction, frequency, and polarization. Try as you might, you could never remove all the photons from any given state. According to the principles of quantum mechanics, every state must have a minimum population of either zero or one photon, with equal probability. The average of zero and one is one-half. Therefore there must be, on average, the equivalent of at least half a photon in every possible state.

Half a Photon Here, Half a Photon There

Half a photon in each state is not much -- a 100-watt light bulb puts out 100 billion billion photons every second -- but there are countless possible states. The result is a vast sea of radiation underlying the universe. All those virtual photons constitute the electromagnetic zero-point field, so named because it is present even at a temperature of absolute zero. In the deepest reaches of intergalactic space, where particles are so widely spaced that their mutual interactions are weak, this irreducible radiation field comes into play. In 1910, about halfway between the publication of special and general relativity, Einstein and his colleague Ludwig Hopf investigated how a thin gas would react when immersed in an electromagnetic radiation field. The radiation, they found, would have two counteracting effects on each gas particle. The particle would jiggle as photons bombarded it at random, but its motion would be opposed by a drag force due to the Doppler effect. The Doppler effect would stiffen the

resistance of photons in the direction that the particle was trying to move. The particle would smack head-on into blueshifted photons, which, being more energetic than the photons from other directions, would push it back the way it came. This drag force would prevent the random jiggles of the gas particle from developing into net motion.

The Einstein-Hopf process would be an interesting, but irrelevant, curiosity were it not for one peculiarity that sets the electromagnetic quantum vacuum apart from other radiation fields: the shape of its spectrum. The shape is exactly proportional to the frequency cubed -- precisely the right shape to be "Lorentz invariant." A spectrum with this shape does not produce a Doppler effect. The photons that a gas particle meets head-on in the quantum vacuum are no more energetic than those that strike the particle from behind. Consequently, the photons can offer no concerted resistance to uniform motion. (The spectrum and directional distribution of photons, however, do change for particles that are accelerating; this is the origin of inertia in our theory, as discussed in the box on p. 15.)

This idiosyncrasy of the vacuum electromagnetic field throws the Einstein-Hopf process out of balance (see figure on p. 14). Once gas particles are set in motion by the random fluctuations of the electromagnetic field, nothing can stop them. Over millions of years they accelerate steadily, reaching velocities near to that of light and moving across astronomical distances.

Astrophysicists are no strangers to this mechanism. Twenty years ago, one of us proposed it as a possible source of the most energetic cosmic rays. Most cosmic rays consist of electrons, protons, and ions, but those of extremely high energy are missing the electrons. The Einstein-Hopf process would explain this, because it operates more efficiently on protons and ions than on electrons. What no one had considered was that this process could also segregate matter on a cosmological scale.

When we first looked into the matter, the Einstein-Hopf process sounded too good to be true. By transferring energy from virtual photons into real particles, would the process yield something for nothing? To check, we teamed up with IBM physicist Daniel Cole, an expert on the quantum vacuum. For over five years, Cole had been assessing whether theories of the vacuum violate any basic principles, such as the conservation of mass-energy or the second law of thermodynamics. He was able to find nothing amiss with the quantum Einstein-Hopf mechanism.

Emptiness Begets Emptiness

The Einstein-Hopf process works best in places where particles hardly ever collide with each other, since collisions prevent the particles from building up speed. The less matter there is, the more the matter wants to go

someplace else. Thus the tendency is for regions of low density to empty out even more, and for regions of high density to become denser. This is exactly the sort of snowball effect that cosmologists have been looking for to explain how matter congregated to form sheets and walls. At some point, the acceleration must have come to an end, or else all matter would have clumped into a single mega-galaxy. We believe that the end drew near when the agglomerating sheets developed appreciable magnetic fields. As the particles scurried into sheets, they dragged along their primordial magnetic fields. Those fields piled up, creating a magnetic pressure that ultimately balanced the Einstein-Hopf evacuation process. Gravity took over to form smaller structures, such as galaxies. The end result, we proposed last spring in *The Astrophysical Journal*, was the honeycombed structure of the universe.

The theory rests on many assumptions, and the one that worries us is the most fundamental: that the quantum vacuum produces a real electromagnetic field. Physicists normally treat the virtual photons as just that: virtual, hence unable to produce any far-reaching real effects. But numerous experiments indicate the field may indeed influence matter. The quantum vacuum creates an attraction between neutral parallel plates, as predicted by Dutch physicist Hendrick Casimir in 1948 and confirmed experimentally several years later. The interaction of the vacuum electromagnetic field with electrons causes a shift of hydrogen spectral lines, as discovered by American physicists Willis Lamb Jr. and Robert Retherford in 1947 and explained later that year by Hans Bethe. And the spontaneous emission of photons can be altered by changing the electromagnetic environment of atoms; this suggests that "spontaneous" emission is actually stimulated by the fluctuations of the vacuum.

If the zero-point field is real, it should be possible to reproduce the Einstein-Hopf process in the laboratory. The main obstacle would be achieving densities comparable to those in the cosmic voids: less than one particle per cubic meter. But if we could even approximate this, the effect might be measurable. One possibility would be to create an extremely low temperature magnetic trap and inject anti-protons into it. If the Einstein-Hopf process ejected the anti-protons, the experimenter should see them annihilate with protons in the matter surrounding the trap.

The idea that the zero-point field might really exist dates to the early 20th century, when there was not yet a clear division between classical and quantum physics. Quantum mechanics emerged from a radical, and unsupported, assumption that German physicist Max Planck made in 1900: that the energy of a system can only take on certain discrete, or quantized, values. >From this hypothesis, he was able to explain the blackbody spectrum of the light that stars and other glowing bodies give off. Planck searched for something to explain the quantization, and one possibility he considered was

that space is filled with unseen energy, a proposal also made by Walther Nernst in 1916.

During the 1920s, quantum mechanics proved so successful that physicists abandoned the search for an underlying cause of quantization. Quantization, like inertia, came to be regarded as just a given, a new law of nature. But in a series of papers beginning in 1969, Timothy Boyer appears to have vindicated Planck by deriving the blackbody spectrum directly from classical physics, without quantization -- by positing a background zero-point field. This reopens the questions that concerned Planck.

Is it possible that quantum mechanics is classical physics done in the presence of a zero-point field? Could the counterintuitive laws of quantum physics someday go the way of Ptolemaic epicycles? Quantum mechanics is certainly successful in terms of predicting observations, but so was Ptolemaic astronomy. In fact, the Ptolemaic system predicted planetary positions much better than Nicolaus Copernicus's initial theory. If astronomers had simply rejected the Copernican model, rather than worked to fix its shortcomings, we would still think Earth is the center of the universe.

As Planck did when he first derived the blackbody spectrum, we have taken a pragmatic approach: suppose that the quantum vacuum does produce real effects and consider the implications. Many new theories are ad hoc, conjured up to explain one thing and unable to explain anything else. The fact that the zero-point field might account for inertia, gravity, quantization, and, now, cosmic voids indicates that it is worth investigating.

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Illustration captions

An astrophysical Genesis. More precisely, this is a map of the cosmic microwave background radiation, which reflects the distribution of matter shortly after the Big Bang. Darker areas had a higher density, brighter areas a lower density. NASA released a similar map in 1992, but it was based on preliminary measurements, which were so prone to noise that scientists could not be certain what was real. This latest map, released in January, contains more signal than noise. Even the smallest feature on the map is far larger than the largest structure astronomers see in the universe today. Images courtesy of Charles L. Bennett, NASA Goddard Space Flight Center.

Holes. The universe is full of holes. The regions shown on this diagram, which depicts a cube 500 million light-years on a side, are all but empty of luminous matter. These voids interconnect like the holes in your kitchen sponge. This diagram is based on an early-1990s redshift survey of infrared galaxies by Queen Mary College, the University of Durham, Oxford University, and the University of Toronto. Our Milky Way is at the center. Diagram courtesy of Carlos S. Frenk.

The Einstein-Hopf process. In a near-vacuum, collisions between gas particles are rare; collisions between particles and photons are more important. The photons are part of whatever electromagnetic field the particles happen to be immersed in. These photons are always hitting each particle from all sides, but not with equal strength. Those that hit a moving particle head-on are more energetic than those striking from behind, because of the Doppler effect. This imbalance automatically keeps the particle velocities in check (top). There is one exception: If the dominant electromagnetic field is the zero-point field, the spectrum of the field cancels out the Doppler effect, so that photons striking head-on are no more energetic than any other photons (bottom). As a result, the particles are free to move without restraint. Diagrams by Bernhard M. Haisch.

The Illusion of Mass

Maybe there is no such thing as "mass" -- only charge, which gives the illusion of mass when it is immersed in the quantum vacuum. It is an audacious idea, but one that would unify gravitation with the other fundamental forces of nature. Physicists universally accept the reality of the quantum vacuum, a sea of virtual particles and photons that wink in and out of existence too fast to be seen. But physicists are less confident that the virtual photons could create a real electromagnetic field. For starters, this zero-point field would raise problems with general relativity.

Einstein's theory states that energy produces gravity in the same way that matter does. Just as a planet attracts other bodies gravitationally, an electromagnetic field attracts bodies gravitationally. A uniform zero-point field

that filled the universe would be an enormous source of gravitation -- so enormous that it should reduce the universe to microscopic size. This is clearly not the case.

Two linked theories have been proposed to resolve this paradox. If correct, they would constitute a paradigm shift in our view of matter itself. The first theory grew out of a suggestion made by the Russian physicist Andrei Sakharov in 1968 that gravity could originate in the quantum vacuum. Harold Puthoff published a quantitative, albeit preliminary, development of this idea in 1989. According to his theory, the zero-point field would cause charged particles, such as the electron or the quarks inside protons and neutrons, to oscillate. Whenever a charged particle oscillates, it emits electromagnetic waves of its own. These secondary fields would attract other charged particles.

If true, this theory would unify gravity with electromagnetism -- an unexpected resolution to the long search for a unified theory. It would neatly answer the general relativity paradox. In this view, gravitation is caused by secondary fields induced by the zero-point field; the zero-point field, in and of itself, cannot produce gravitation.

The second theory is our proposed mechanism for inertia. Einstein's principle of equivalence tells us that inertial and gravitational mass are the same. If gravitation is electromagnetic, inertia must be, too. This implies a complete rethinking of what matter really is.

The zero-point field is completely uniform for observers in uniform motion. But it is asymmetric for observers in accelerated motion. In 1994, we and Puthoff examined a phenomenon no one had thought to investigate before: how the magnetic component of the zero-point field interacts with matter during acceleration. The result was surprising, to say the least. The magnetic Lorentz force opposed acceleration with a strength that varied in direct proportion to the magnitude of the acceleration (see figure). It looked like a derivation of Newton's second law, $F=ma$, heretofore considered an underivable postulate.

What we feel and interpret as "mass" is, in this theory, an electromagnetic resistance arising out of the zero-point field. If it is true that mass is a consequence of charge, rather than an inherent property of matter, it might be possible (in the distant future) to build anti-gravity devices that would switch off the inertia of objects.

Are there objections to this theory? Certainly. We propose it not as a done-deal, but as a new approach to long-standing, unresolved fundamental problems. There are two major reservations. First, we treated the quantum vacuum as if it were a perfectly real electromagnetic field. The available evidence on this issue is ambiguous, and more experiments need to be done -- ranging from laboratory measurements of the Casimir force to astronomical observations of large-scale structure in the universe.

Second, even our simple model demanded a complex mathematical analysis, which is difficult to verify. For instance, we ignored non-electromagnetic vacuum fields, such as those associated with the gluon particles that bind quarks together. We are now completing a different approach that avoids this and other problems, and the preliminary results have confirmed the first approach. We hope that more researchers will look into these problems, drawn by the appeal of unsuspected deep connections.

Illustration caption

The origin of inertia? Quantum mechanics predicts that photons are constantly flitting on and off the stage of existence. These photons are "virtual" in that each survives so short a time that the rest of us hardly notice. Collectively, however, they have observable effects, one of which was predicted by physicists Paul Davies and William Unruh in the mid-1970s and studied in detail by the authors. To a particle sitting still or moving uniformly, the field of virtual photons looks the same in all directions (top left). But as the particle begins to accelerate, the field ceases to look the same in the fore and aft directions (top center). For faster accelerations, the asymmetry worsens (top right). Physicists had thought the Davies-Unruh effect was an esoteric curiosity significant only near black holes. But the authors have found that the asymmetry creates a force similar to the radiation pressure that pushes cometary dust tails away from the Sun. This force always opposes the acceleration (bottom). Voilà, inertia. Diagrams by Bernhard M. Haisch.

ZERO-POINT VACUUM FLUCTUATION

TOWARDS A UNIFIED ELECTRODYNAMIC VIEW OF THE FUNDAMENTAL FIELDS OF NATURE

BY DON REED, RAUM&ZEIT, VOL 3, NO 2, 1992

We surveyed a novel electromagnetic field based on the topology of a Moebius band or a Klein bottle. This field is apparently the agent for the production of unique phenomena, chief of which among these is the decrease of gravitational potential or mass of certain substances placed within the proximity of the field.

Such phenomena are clearly foreign to present scientific understanding. from the standpoint of the bodies of knowledge underlying relativity, quantum physics, and even classical electromagnetic theory. However, it is not entirely inconceivable that the structure of nature at its primordial sub-atomic level might be the seat of a ubiquitous groundform energy field. Furthermore, its dynamical characteristics could account for known phenomena in the relativistic and quantum domains, as well as certain recorded anomalous phenomena which cannot as yet be incorporated into contemporary scientific paradigms.

Exactly such a feature has played an important role in explicating many of the initially enigmatic findings of quantum electrodynamics in particular. It has been termed the "zero-point vacuum fluctuations," or ZPF. The name derives from the existence of this basic energy even at the lowest temperature in nature, 0° Kelvin. One of the substantial effects of this postulated fluctuating vacuum groundform is the oscillatory feature ascribed to the electron as it interacts with the ZPF, known as the "Zitterbewegung" or jitter (ZBW will be suitable for our purposes). In view of the recent emergence of operating free energy machines, it will be advantageous to study the characteristics of the Zitterbewegung. In this light, focusing on the ZBW will provide us with a rational basis with which to ascribe the workings of such devices, to prevent the classification of them as perpetual motion machines.

At this juncture, it would be prudent to outline to readers unfamiliar with these topics, the history of discoveries in the peculiarities of electron behavior that brought these notions to light. The initial difficulty came at the turn of the century with the aborted attempt by H. A. Lorentz to compatibly integrate the electron into the electromagnetic field theory of Maxwell-Hertz.(1) The problems arose from Lorentz' assumption of a spherical charge distribution

emanating from an electron treated as a structureless point source of the Coulomb electrostatic field. The result obtained was a quantitatively divergent (infinite) interaction energy between the electron and its own radiation field. Despite many later attempts to correct this defect, none have yet succeeded. In the mid-1920s, the spectral evidence of the so-called "anomalous" Zeeman effect, as well as the observed space quantization of the electron magnetic moment demonstrated by the Stern-Gerlach experiment, compelled physicists to ascribe to the electron a self angular momentum factor called "spin."⁽²⁾ Yet the quantum aspects of this particular dynamics showed that spin could not in any sense be related to the intuitive notions of ordinary rotational motion. It was the first phenomenon in the history of science that had absolutely no correspondence with any concept in the macroscopic world. The mysterious nature of this notion was underscored by Born when he described it as: "The idea of a spin without the existence of something spinning ...". Moreover, any attempts to ascribe a geometric structure to spin were summarily prevented by the development of the Schrodinger wave equation and Heisenberg matrix wave mechanics in the late 1920s. According to the philosophical underpinnings of this so-called Copenhagen Interpretation of quantum theory, no structure of sub-atomic units (apart from point particles) is possible.

In the early 1930s, Dirac's model, based upon a relativistic covariant linearization of the Schrodinger equation, demonstrated that electron spin is a direct consequence of the mathematical structure of the theory.⁽³⁾ Specifically, this entailed the use of a unique four-component wave function (spinors) which accounted for the observed half-integral spin of the electron, the anomalous Zeeman effect, and the existence of negative energy states by the prediction of the positron.

By the middle 1940s, the Dirac theory was found to be deficient since it could not account for the small, albeit measurable, anomalous magnetic moment of the electron. Through quantum electrodynamics as developed by Schwinger, Bethe, Feynman, the reason for the anomalous moment was discovered to be due to the electron's self-interaction with the substratum vibrations. To this, in turn, was appended the term zero-point vacuum fluctuations. One key experiment which verified the influence of the ZPF, was the Lamb shift of the spectral lines of hydrogen.⁽⁴⁾ The Zitterbewegung motion (ZBW), was then applied to the reaction of the electron to the ambient ZPF, describing the area in which the electron tends to oscillate with the dimensions of the Compton wavelength ($\lambda_c = h/mc$). Actually, the concept of the ZBW concept was first introduced by Schrodinger to interpret high-frequency oscillations in free particle wave packets of the Dirac theory. These oscillations, with angular frequency $2mc^2/h$, were interpreted as interference between positive and negative energy components of a wave packet.

Until recently, the majority of the practitioners of quantum field theory attributed no real significance to the ZBW. It was held that the ZBW is a mathematical artifact of the one-particle Dirac theory, which does not appear in a correctly formulated quantum field theory. Others, inasmuch as, claimed that the ZBW is an inconsequential erratic motion of the electron due to random electron-positron pair creation and annihilation. However, important new evidence has surfaced causing a growing group of the physics community to regard the ZBW in a more substantial role. Indeed, the findings reached by several prominent theoretical physicists(5) is that the ZBW is a localized helical motion of the electron with an angular momentum which can be identified with the electron spin. In re-casting the Dirac theory in the Clifford analysis of his multivector geometric algebra, D. Hestenes(6) has said to bare the geometric content of electron spin, which has been formerly shrouded by the formalistic artifice of matrix mechanics and quantum field theory. According to these findings, the ZBW need not be attributed to interference between positive and negative energy states as Schrodinger originally proposed, but provides the key to a complete understanding of the Dirac theory of the electrons, including a physical interpretation for the complex phase factor in the Dirac wave function. Furthermore, he has convincingly revealed, through mathematical argument, the unprecedented picture of the electron as the seat of a bound oscillating electromagnetic field similar to de Brogue's concept of a pilot wave. Thus it tells us that the ZBW is responsible for a kind of electromagnetic wave-particle duality which is implicit not only in the Dirac theory, but has manifestations in every application in quantum mechanics, even in the non-relativistic domain covered by the Schrodinger theory. Contrary to orthodox opinion which views the electromagnetic field as merely incidental to quantum theory, the new findings by Hestenes and others, ascribes a central role to the electromagnetic field. In this sense, not only is the latter a generating source for ZPF, but it is the seat of the associated electron Zitterbewegung, its characteristic half-integral spin, and all other manifestations of quantum physics including the uncertainty in position and momentum of subatomic units. The uncertainty relations can now be viewed as consequences of a zero-point particle motion with a fixed zero-point angular momentum, the spin of the electron. This explains why the limiting constant $\hbar/2$ in the uncertainty relations ($\Delta x \cdot \Delta p = \hbar/2$) is exactly equal to the magnitude of the electron spin.

In this regard, the once obscure paper of Furutsu(7) takes on the significance of landmark proportions. His two-part monograph investigation, in conjunction with Hestene's work and the work of Puthoff, to be described, deserves close scrutiny by all theorists concerned with explicating the fundamental questions of physics. Furutsu mathematically showed that the classical statistical theory of electromagnetic waves in a fluctuating medium

corresponds to the commutation relations in the quantum mechanics of the Heisenberg equation of motion. Specifically, there exists a one to one correspondence between the so-called Green's function in the statistical wave theory. and the associated probability amplitude function in quantum mechanics. which satisfies the Schrodinger equation.

Although these revelations indeed point to a possible major role of the electro-magnetic field in quantum mechanics. the reader may well wonder what significance such findings may have for revealing the long sought-after master field of nature under which both gravi-tational and electromagnetic phenomena are unified and subsumed. For one thing, the discovery of a sub-atomic feature demonstrating the theoretical link between gravitation and electro-magnetism would tend to help place such phenomena generated by the Moebius Electromagnetic field in a more substantial and less of a fictional light when considering possibilities for viable future alternate energy sources.

One key for the realization of this primordial unified field structure. is to adopt the model originally promoted in 1967 by Sakharov.(8) This model purports that gravitation is not a funda-mental interaction at all. but rather an induced effect brought about by changes in the ZPF when matter is present, in much the same way as the Van der Waals and Casimir forces. Pursuing the Sakharov hypothesis further, in a recent article in the Physical Review, H. Puthoff (9) develops a classical model of ZPF founded upon the related work of T. Boyer on stochastic electrody-namics.(10) The Puthoff work predicts a value for the Newtonian gravitational constant G which is determined as a direct function of the oscillatory frequency of the ZPF:

$$G = \frac{\pi c^5}{2\hbar \omega_c \omega_d \omega_w}, \quad \omega_c = (\pi c^5 / \hbar G)^{1/2}$$

where ω_c corresponds to an effective Planck cutoff frequency of the ZPF spectrum. Thus the small value of the gravitational constant is an inverse reflection of the high frequency cutoff value of the ZPF. Here, gravitational mass is shown to correspond to the kinetic energy of the ZPF-induced particle motion, or ZBW. while the customary attractive inverse square law force is attributed to a long range Van der Waals type. associated with the broad spectrum ZPF radiation fields, also generated by the ZBW. Now we are beginning to clearly see a pattern developing which possibly reveals the ZPF as the master electrodynamic field underlying all phenomena in physics.

Considering the high oscillatory frequency of the ZPF ($\sim 10^{24}$ cycles per second), one might wonder whether the microscopic domain could be engineered as a viable energy source. Following this lead, in another article(11) Puthoff suggests that engineering of the ZPF might have enormous implications for power generation. He bases this view on the so-called Casimir effect, which is an experimentally verified ZPF-induced powerful attractive quantum force between closely spaced metal or dielectric plates. Along these

lines Puthoff suggests that engineers try designing zero-point energy machines with a cold, charged plasma or gas. Like the metal plates, the Casimir effect would pinch the plasma together producing energy in the form of heat and condensed charged particles.

The various so-called free energy devices now in operation might be employing similar principles, allowing coherence of the ZPF under specific excitation of the vacuum, producing visible macroscopic effects. One such device is the Plasmatron generator built by Moscow physicist A. Chernetsky.(12) This apparatus reportedly takes 700 watts of electricity, and via heavy current pulse discharge created through unstable plasma states, gives back 3500 watts manufacturing slightly more than three horsepower out of nothing. The mysterious discharge stimulating additional energy extraction was called self-generating discharge. Measurements showed that part of the discharge power went back into the network as if two series-connected electromotive forces are at work. In one special test, current discharge was so great that a megawatt substation near the experiment burned out. This brings to mind a similar event experienced by Nikola Tesla during one of his experiments where a power plant caught fire. It is entirely possible that vacuum energy from the ZPF can explain both these incidents.

Another prominent energy device which operates independently of any priming power other than a manual start, appears to be a true free energy system. This is the Swiss M-L Converter first mentioned by Davidson in his book *The Secret of the Creative Vacuum*.(13) It provides some of the power used by the spiritual community of Methernitha. The dynamic components of this device constitute a modern version of a self-propelled Wimshurst machine, with large Leyden jars forming capacitors for electrostatic energy storage.(14) Once the machine is started manually, the high electrostatic potential generated primes the system. Solid state components include twin bifilar-wound coils situated within the capacitors. In addition there are two horseshoe magnets also wound with bifilar coils and other self-standing capacitors connected in the circuit. Interestingly, this is a hybrid system, since it involves both dynamic and solid-state conversion features. There is a harmonious combination of electrostatic as well as electromagnetic circuit elements. Notably, a similar hybrid power combination comprised the Hutchingson-Hathaway experiments of the 1980s, which produced anomalous phenomena via the crudely constructed arrangement which adjoined a Van Der Graaff generator to two modified Tesla coils, along with other field-shaping elements.(15) The videotaped record of these experiments shows the complete levitation of several objects including 20 pound tool boxes, as well as the frequent catastrophic fracturing of pieces of metal or other samples, giving them the appearance of corrugated cardboard.

Another device in which output power is claimed to exceed that input by a factor of ten, is the recent invention by Hyde.(16) Although not too many details apart from the patent are yet available, electrical engineer M. King offers an excellent analysis of its principles of operation as well as interesting insight into its mode of anomalous energy generation.(17) Once again, the coherence of the ZPF is counted among the main possibilities for this surplus energy production.

Thus, in many ways it appears that the concept of the passive 19th century luminiferous aether plenum that had been banished with the advent of Einsteinian Relativity. has returned in a much different guise invested with the dynamic properties of the ZPF as enumerated by quantum field theory. In the next chapter of this series. we will examine a specific geometric model for this primordial energy field. based upon the toroidal topology invested within Kenneth Killic's tachion pair arrangement. In accordance with this model, the land-mark work of physicist Peter Gschwind will be investigated and found to contain a natural mathematical structure (biquaternion analysis) which, in a projective geometric framework, can be effectively brought to bare on many of the current enigmas of physics.

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