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# Conservative hadron interactions exemplified by the creation of the kaon

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Following the theme of earlier *Hadronic Journal* papers discussing meson creation in terms of conservation of energy, charge, and the volume of space bounding charge, it is shown that there is important evidence bearing upon the mediating role of the Japanese *H* quantum as a graviton. Gravitation as a quantum-based phenomenon in the special sense of its association with discrete particle resonance states is a possibility that has been ignored. This paper develops on this theme and extends in detail the author's earlier summary description of the kaon creation process. The relevant meson masses are deduced and found to be in full accord with measurement data.

## I. INTRODUCTION

In a series of three *Hadronic Journal* papers in 1986,[1-3] the author has disclosed an energy correlation technique which gives a comprehensive account of the hadron mass spectrum. In order to assess what this research offers that is not provided by the more conventional quark theories, it now seems appropriate to discuss particular aspects of the theory, whilst presenting some new advances.

It is of basic importance to any research program concerning high-energy particle physics to know whether the high-energy research is really representative of what occurs or has occurred in nature or whether the experiments are such that we are investigating a realm extending outside nature's own range of action.

Stated in general terms, our knowledge of natural particles concerns the stable particles which form matter on earth and the particles which are detected in cosmic radiation. Cosmic radiation involves high energy, but that energy does not, in the main, consist of rest-mass energy of massive particle species. In contrast, particle accelerators now harness such high energies to bring particles into collision in such a way that it becomes debatable whether particle species created in accelerator experiments actually exist in a natural form.

The assumption, of course, is that our experiments are replicating conditions that we associate with the creation of the universe, but whatever emerges from such experiments cannot, with certainty, be declared as having really occurred in such primordial events.

It is the author's contention that particle physicists are researching high-energy fields without pausing to establish sufficiently the solid foundation relating to what exists naturally. We should be mindful of the need to understand the nature of the proton, the neutron, the muon, the pion and the kaon, and that should not be neglected in our search for heavy bosons and the imaginary Higgs particle. Undoubtedly, in the synthetic creation of particles at ultrahigh energy, something will appear that might well be claimed as satisfying our expectations, but there is the danger that something will be forced out of such research in a way that can mislead us. At the very least, the resources assigned to such research divert us away from the more detailed study of the properties and interactions of the basic particles. Also, the commitment to a particle classification based on exotic quark properties can polarize thought away from acceptance of alternative and more fruitful theoretical lines of investigation.

Experiments can, of course, only operate to reveal nature's capabilities and so are bound to tell us something of nature's inner mechanism, but the pursuit of science to its limits can be no excuse for ignoring opportunities that are within reach and bear more closely upon the mysteries of what nature has chosen to reveal at normal energy levels.

Of particular concern is the way in which a promising research route having significant empirical implications can be ignored as research focuses on experimental effort related to a primary theoretical theme. In mind here is the Japanese *H* quantum, which was revealed by research into cosmic radiation and supported by particle-accelerator research. The theme of this was that evidence pointed to the ultrahigh overall energy state of a cosmic fireball being governed by a cascade of *H* quanta set by an energy threshold at around 2.5 GeV.

The implication from this is that, whatever might be achieved by particle resonance in high-energy collisions under artificial accelerator conditions, nature, left to operate in its own way, likes to keep a limit on the rest-mass energy of particle forms. This is what we see in the fields of free space, but in the dense matter constituting heavy atomic nuclei there could be field conditions which resonate at levels measured by the heavy-boson conditions close to 100 GeV. By building bigger and more powerful particle colliders to probe free-space energies at the level of hundreds of GeV, what can be achieved at the order of a few GeV is neglected. Though it might be thought that all resonance states in the low GeV range are now known, this may be far from the truth, especially if the resonance has a very narrow peak.

Before discussing this subject and its bearing upon the author's prior work, we will now examine an aspect of the processes which govern, in the author's opinion, the creation of the charged kaon, which is a particle found in cosmic radiation.

## II. THE CREATION OF THE KAON

So far as the author is aware, the reason why the kaon has a mass energy of approximately 493 Gev has no explanation in accepted particle theories. It is supposedly composed of quarks to which mass-energy components can be assigned, but there is nothing definitive about the empirical evidence involved, and in the absence of quark isolation there is room for doubt.

In contrast, the author's own analysis has given a definite basis for deducing the existence of the charged kaon in terms of a coalescence of virtual muons. The theory[2] is based upon three principles concerning charge conservation, energy conservation, and space-occupancy conservation, respectively.

In the kaon theory as already published it was sufficient to affirm that the space-occupancy criterion was the regulating factor, coupled with charge parity and the condition that the merging muons could supply adequate energy. This sufficed to give a kaon mass energy of approximately 493.6 GeV, but the theory can do better than this if rigorously applied.

Readers of the author's earlier papers[1-3] will see that the "virtual" muon has a derivable mass energy that is 206.3329 times that of the electron rest mass. This is slightly smaller than the mass of the real muon, which is seen as having a composite form.[4,5] The latter mass is calculable as 206.7683 in electron units, as these two references show.

Generally speaking, hadrons are seen as having a composite structure in which there is a state involving, for a charged particle, three components. For the positive kaon it is found that this state involves two similar positive charges $+e$ disposed on either side of a central charge $-e$. The specific form of the kaon is that for which the overall energy of this three-charge state is exactly that applicable when the state changes and the central charge stands in isolation with its polarity reversed. This is a unique specification if one imposes the condition that the two states are equally probable and the requirement that the kaon be synthesized from a merging of muons.

The analysis is given in Ref. 2, but may be summarized by the equations

$$n(1/\mu)^3 = (1/S)^3 + (1/K)^3, \tag{1}$$

where

$$n\mu \geq K \tag{2}$$

and

$$K = K + 2S - \frac{9}{4}\frac{SK}{S+K}. \tag{3}$$

Since the radius of a sphere bounding a charge $e$ is inversely proportional to the total energy of that charge, Eq. (1) is a statement of conserved space occupancy on an average basis, allowing for fluctuations, when $n$ virtual muons of energy $\mu$ produce a system of two $S$ energy charges and one $K$ energy charge which converts for equal time to a simple $K$ system. Equation (2) merely prescribes that the muon energy must suffice to supply the energy $K$, whereas Eq. (3) states that $K$ equals the composite energy of the two $S$ charges plus the $K$ charge as offset by the Coulomb interaction energy involved.

Solving (3), $K$ is $8S$, and this gives

$$(K/\mu)^3 = 513/n, \qquad \text{where} \quad (K/\mu)^4 \leq 513. \tag{4}$$

This requires a minimum value of 5 for $n$ and gives $K$ as $4.68147\mu$. With $\mu$ as 206.3329 times the electron mass, this yields 493.596 MeV as the rest-mass energy of the kaon.

This model showing how the kaon is produced may not represent the final state of the kaon, but only the energy quantum involved. Conceivably the kaon settles in a more stable form, possibly still involving three charges. However, the author feels that a final opinion on this has to depend upon the ultimate determination of the kaon lifetime and a better measurement of the kaon mass. The theory for the kaon lifetime based on the author's methods has not yet been developed.

To advance the reader's understanding of the underlying principles of the author's methods, attention is now drawn to the lepton group equations used in Ref. 1 and used, in their electron form, as a basis for the neutron mass evaluation. These equations are based upon a rigorous conservation of charge, energy, and space. They involve what the author terms "Thomson charge groups," which form part of a neutral lepton "gas." These comprise two alternative forms, symbolized by $(2\mu:\mu)$ and $(\mu:\mu)$, which have, respectively, energies $2\mu$ and $\frac{5}{4}\mu$, and volumes $\frac{9}{8}$ and 2 times that of the self-standing virtual muon.

Suppose now that such a gas having its equilibrium mixture of these two group types is called upon to behave in a way which is fully compatible with all three conservation criteria when creating kaons from muons. Thus, energy is absorbed in 7 units of $\mu$ when 9 virtual muons merge to create 8 $(2\mu:\mu)$ groups. There is no space adjustment in this, just an energy change. Similarly, energy can be released in 3 units of $\mu$ when 8 virtual muons merge to form 4 $(\mu:\mu)$ units, again with no space adjustment. This action is reversible, depending upon whether adjustments release or absorb energy in these quanta.

This tells us that the energy imbalance governing the space creation process can be assured provided the "fireball" process in which kaons are created admits energy adjustments in units of $7\mu$ and/or $3\mu$.

The scenario we now consider is that involving the creation of $N$ kaons by the process already described. This involves $5N$ virtual muons to set up the space volume for the $N$ kaons, but we need to deploy the surplus energy resulting from the fact that each such kaon only needs a minimum energy of 4.68147 muons.

Note now that the energy equation (3) presumes that the $S$ charges have exactly the same volume and energy. In practice, they could be marginally different, allowing a small energy increment whilst the total volume is conserved, but the quasistability criteria militate in favor of very near equality. The task, therefore, is to estimate the likely value of $N$ in the "fireball" process generating the kaon species.

The value of $N$ sought is that for which we have the optimum solution of the form

$$N(5 - 4.68147) = 7\alpha + 3\beta, \tag{5}$$

where $\alpha$ and $\beta$ are zero or small negative or positive integers. The optimum solution seems to be that for which $N$ is 22, with $\alpha = 1$ and $\beta = 0$. This satisfies the relationship

$$22(5 - 4.681818) = 7 \tag{6}$$

and gives the kaon mass energy as 493.633 MeV.

Note that this result is within 67 parts in a million of the $S$ equality value, which gave 493.596 MeV. The nearest for a lower value of $N$ is that with $N = 19$, $\alpha = 0$ and $\beta = 2$. This gives

$$19(5 - 4.684210) = 6, \tag{7}$$

but it corresponds to a kaon mass energy of 493.885 MeV and is 577 parts in a million removed from the $S$ equality value.

The process likely to predominate is that which gives the nearer-to-minimal state with the fusion of the 22 muon quanta. The theory, therefore, very definitely favors a value of 493.633 MeV as the rest-mass energy of the charged kaon. Data sources[6] give the average measured value as 493.667 ± 0.014 MeV, but this average is based on only three independent observations, the most recent of which is a 1981 measurement of 493.640 ± 0.054 MeV. The theoretical value obtained above is certainly well within the standard deviation of this measurement. It is also within 1.20 standard deviations of the first-listed, 1975 measurement and within 1.28 standard deviations of the second-listed, 1979 measurement.

In these circumstances it is submitted that the theory offers an excellent quantitative determination for the kaon mass energy and it does this by strict conformity with all three of the conservation rules as rigidly operative.

The reader should see from this discourse why there is real purpose in putting effort into the more precise measurement of kaon properties, because verification of such a theory can open more rewarding research avenues for the primary investment in high-energy particle physics.

The action described suggests a "fireball" creation of kaons, which seemingly involves the virtual muon background in the packaged creation of 22 kaons in a single event. This presumes that only kaons are being created, rather than a hybrid mixture of several particle products in the immediate environment. An overall energy threshold of very nearly 11 GeV is involved in such a "fireball" situation.

It occurred to the author to check for evidence of such a high-energy quantum in the listings of the Particle Data Group.[6] These do in fact reveal a meson of nominal energy 10 860 MeV and typified by a measurement at 10 865 ± 4 MeV. If this were evidence of the 22-kaon energy threshold, it would correspond to a charged kaon mass energy of 493.86 ± 0.18 MeV , which compares well with the theoretical value of 493.633 MeV and the 493.640 ± 0.054 MeV given above as the measured value.

Of course, in the light of what has just been said, it is natural to look for evidence of a resonance connected with the 19-kaon energy threshold, just to see if the related "fireball" meson can also be created. This would have an energy of $19(5)\mu$ increased by 577 parts in a million, where $\mu$ is the mass of the 206.3329 virtual muon quantum in electron mass units. This is found to be 10 022 MeV, and indeed, the upsilon (10 023) resonance is listed on p. 231 of Ref. 6.

## III. THE MASS OF THE TAU LEPTON

In Ref. 3 the mass energy of the tau lepton was very rigorously determined by the same theoretical criteria. The tau is seen as being of predominant importance in that, like the virtual muon, it has a real role and general presence in the latent state of the vacuum field. The kaon, on the other hand, is subject to erratic by-product activity in a synthesis which produces a short-lived species that does occur naturally, but is not a normal constituent of the matter state, as is the pion.

It is of interest to compare the theoretical mass-energy value of the tau and the measurements listed by the Particle Data Group.[6] The tau-proton mass ratio was shown to be simply 3 raised to the power $\frac{7}{12}$. This leads to 1781.062 MeV for the tau mass.

There are four listed measurements of the tau mass in the 1986 data. They are:

1783 ± 3
1787 ± 10
1807 ± 20
1803 ± 16

Quite clearly, therefore, we have no basis at this time for doubting that the theoretical value is the true value. In averaging these four measurements the three relatively imprecise measurements weight the nominal estimate upwards to 1784 MeV, but in view of the uncertainties involved it seems more logical to rely only on the most precise measurement in the above list. The theoretical value lies well within the standard deviation.

It remains to be seen whether progress in measuring this important quantity in the years ahead will give better confirmation of the theory, but at this time the evidence is good. On this note, we will now examine the more controversial situation that arises from the predicted existence of the 2587-MeV particle. As can be seen from the author's papers[1-3] and particularly Ref. 3, the theory is firm in indicating the need for a major vacuum property conducive to the resonance of a charge nucleating a rest mass energy 2587 MeV.

On this the 1986 listings of the Particle Data Group offer two candidates. On p. 314 of Ref. 6 they list a (2585) "bump," and on p. 275 they list *N*(2600). The latter is based on a reported measurement of a particle at 2577 ± 50 MeV. These are both independent of the 1977 discovery to be discussed below and hardly provide encouraging support for the author's thesis that a 2587-MeV particle has a sufficient power of presence to play a role complementary with that of the tau in mediating in the gravitational interaction.

The existence of the $g$ particle at 2587 MeV was predicted from a fundamental energy-space- and charge-parity-conserving equilibrium between the $g$ and the $\tau$, given by solution of the equation:

$$\left(\frac{g}{\tau}\right)^3 - 3\frac{\tau}{g} - 1 = 0. \tag{8}$$

The basis on which this formula is developed is the existence of a fundamental space-volume-to-mass ratio, which gives an exact quantitative derivation of the constant of gravitation $G$, as discussed in Ref. 3. Together the $g$-particle and the tau serve as mediators in the gravitational interaction between matter. Hence it is of major importance to establish the existence of the 2587-MeV quantum in experimental research.

## IV. THE MYSTERY OF THE 2587-MeV QUANTUM

One has reason to be mystified by this absence of strong evidence of the 2587-MeV particle in the Particle Data Group listings, bearing in mind relevant observations reported in the scientific literature.

In 1977 a CERN-based research effort resulted in a paper[7] authored by 30 scientists, which reported on a resonance peak produced by proton-antiproton interaction at 12 GeV. The indicated mass of the charged particle thus discovered (designated the $I$ particle) was 2.60 ± 0.01 GeV/$c^2$.

The half width of this resonance at half maximum was 9 MeV/$c^2$. The resonance was close enough to 2587 MeV for this to be seen as evidence of the $g$-particle. Indeed, it was Dr. D. M. Eagles of the National Measurement Laboratory of CSIRO in Australia who drew this paper to the author's attention, within a month of its publication, referring to it as "good news." Dr. Eagles had published a review paper some months previously[8] in which the author's hypothetical $g$-particle (there estimated as 5062.59 in terms of the electron rest mass) was shown in its $G$-related connection. This paper showed that the author's research compared favorably with rival theories.

With such a clear resonance peak it is difficult to understand why this 2.60-GeV resonance is not included in the 1986 listings of the Particle Data Group. This is even more mystifying when one reads in a very substantial 1982 review paper by Prentice[9] that, in one range of investigation, there is "the longest lived entry giving a fitted mass of 2583 ± 26 MeV/$c^2$" and "one neutral decay candidate ($m$ = 2459 MeV/$c^2$)" which has "a very long proper time."

The (2585) "bump" listed by the Particle Data Group on p. 314 of Ref. 6 was said to have a width of 300 MeV but specified as 2585 ± 45 MeV; however, this hardly reflects the evidence just mentioned.

Digressing momentarily, the author feels it appropriate to consider what, on this theory, happens when a charged $g$-particle develops a quasistable neutral form by pairing with a particle of opposite charge in a way indicated in Ref. 1. Based on the minimal energy state expressed in Eq. (6) of that paper, or the more concise equation (6) of Ref. [10], namely

$$W_{\min} = \left(\sqrt{6} - \tfrac{3}{2}\right)g, \tag{9}$$

this gives a neutral state of energy 2456 MeV with $g$ as 2587 MeV. If the neutral product nucleated by the $g$-particle is not at minimal energy but is held quasistable by the added charged particle, which is a kaon of 493 MeV, then Eq. (5) of Ref. 1 gives the corresponding energy of the neutral aggregation as 2459 MeV. Another likely situation, however, is that arising if the added charged particle is the meson of approximately 785 MeV. This also corresponds to 2459 MeV for the neutral product. There is a reason why the 785-MeV resonance can develop from the tau and pair with a $g$-particle. This is that the energy of the tau can shed the energy of a dimuon in decay to leave two 785-MeV mesons. The tau exists in a gravitational role in company with $g$-particles. Hence it is possible that the 2459-MeV neutral system can be formed.

The author therefore sees this long-lived neutral particle at 2459 MeV in the review Ref. 9 as very relevant support for the charged $g$-particle at 2587 MeV.

Within one year of the publication of the discovery of the $I$ particle at 2.60 ± 0.01 GeV, Apeldorn *et al.*[11] had published their analysis of existing experimental data aimed at seeing whether they could confirm this result. This group was confident that if the resonance existed they would find it in a scan for $K^0, \pi, \pi, \pi$ combinations in the prior established data of a single bin range (2.59 to 2.62 GeV). They expected to find 33 combinations in the light of the claim of Apostolakis *et al.*, augmented to 128 ± 12 owing to background action. They found only 99, and concluded that the observed number was in good agreement with background only, which meant that they were unable to confirm the existence of this $I$ meson.

This rather curious sequence of events leads one to wonder whether the resonance which theory says exists at 2.587 GeV was completely missed by Apeldorn *et al.* restricting their range of verification to one above 2.59 GeV, whereas the Apostolakis data, which did reveal a very well-defined resonance, were not so restricted and may have included data from just below 2.59 GeV. Note also that the bin range scanned was not symmetrically positioned on the 2.60-GeV norm.

Whatever the reason, there is still scope for wondering whether the (2585) bumps and the particle at 2577 ± 50 MeV listed as $N(2600)$ by the Particle Data Group relate to the same resonance at that seen by Apostolakis *et al.*

Before discussing some related evidence from the efforts in Japan concerning the Hasegawa prediction of the $H$ quantum, the author will first refer to an early 1969 account.[12] This aimed at showing how the $g$ particle was in evidence as a participant in building resonance states in particle-collision experiments.

It had been discovered that when protons are supplied to an environment in which pions are being produced, a particle is formed, which at the time (1966) was the largest elementary particle to have been discovered.[13] Krisch *et al.* wrote: "We believe that this is firm evidence for the existence of a nucleon resonance with mass 3245 ± 10 MeV/$c^2$. ... It seems remarkable that such a heavy particle should be so stable."

Again, surprisingly, this particle is not mentioned in the Particle Data Group listing of 1986. Note that the discovery antedates by several years the excitement caused by the psi particle resonances that were found at 3095 and 3684 MeV, respectively. The latter have a derivative connection with the 2587-MeV *g* particle, as mentioned by the author in Ref. 3. However, what is not of record in the scientific papers but is of record in the library copies of the author's 1969 work[14] is the showing that the 3245-MeV resonance points very clearly to the involvement of the *g* particle.

The collision of the proton with a *g* particle in a pion environment will generate pions. The reason is clear from Ref. 14 read on its own or, preferably, in conjunction with Ref. 2. The neutral minimal-energy ($P:Q$) particle group having the energy 891 MeV and formed from the proton in a virtual muon field can, upon coalescence with another muon, produce the ($P:\pi:\pi$) group of mass energy 996 MeV. Subject to a charge source to satisfy charge-parity conservation, pions are created by the catalytic action of this ($P:\pi:\pi$) group for the simple reason that the group ($\pi:P:\pi:\pi$) has exactly the same energy, 996 MeV. Thus an energy surplus can cause pion production, and energy can be absorbed in pion units or, to conform with charge-parity conservation, pairs of pion units. All that is required is an active collision environment involving protons under conditions where pions are known to have a dominant presence. The experiments of Krisch *et al.*[13] produced under these conditions an outstanding resonance at 3245 MeV. The reader may then verify that if the proton rest-mass energy (938.3 MeV) and that of the *g* particle combine in collision to shed the energy of a pion pair (twice 139.6 MeV) to create a resonance at 3245 ± 10 MeV, then the *g*-particle energy has to be given empirically by 2586 ± 10 MeV.

In presenting the above result in 1969, the author was merely adding evidence to support early theoretical work[15] that had predicted the 2587-MeV *g*-particle. This was a dual proposition, because the value was implicit from the *G* derivation, and it had been deduced separately in relation to the electron mass energy from the analysis of the geometrical relationships in a three-dimensional model of the lattice vacuum. The empirical evidence provided by the particle spectrum was just seen as supporting indication. Thus, as early as 1966 in Ref. 15, it was contemplated that two *g* particles might decay in a muon field by each shedding a muon pair and each creating a pair of sigma particles. Taking the known mass energy of one charged sigma form, which is 1189 MeV, this gives the *g*-particle energy as 2(1189) + 2(105.5), which is 2588 MeV.

It was also, at that time, suggested by the theory that a threshold energy equivalent to 1843 electrons and positrons could trigger a transition involving a charge in a vacuum lattice site. This is 942 MeV, and, for example, a *g* particle in a reaction shedding the energy of a muon pair and a pair of 942 MeV units was seen as yielding the 493-MeV kaon energy. This also gave the *g*-particle energy as 2588 MeV.

Further encouragement was seen in 1966 in the process in which two *g* particles collectively shed the energy of a muon pair but each generates a pair of 942 MeV units. This yields an energy of 1197 MeV with a *g*-particle energy of 2588 MeV. 1197 MeV is the energy we assign to another sigma particle.

On the question of whether the ($\pi:P:\pi:\pi$) neutral group of 996 MeV predicted by the author's theory really does exist, it is sufficient to consider what might happen if this neutral system were to divide into two neutral particles of equal mass. The result would be the neutral kaon, as noted for interaction (5) in Table I of Ref. 2. However, using the rigorous theoretical evaluation of the ($\pi:P:\pi:\pi$) energy presented in Ref. 14, which is 1947.389216 electron mass-energy units, the energy is 995.114 MeV. This gives a theoretical neutral-kaon mass energy of 497.557 MeV, which is close accord with the measured value. The neutral kaons produced in the decay of the 2.60-GeV resonance detected by Apostolakis *et al.*[7] were identified as being at 497.7 MeV.

It is then very relevant to note that the natural presence of the ($\pi:P:\pi:\pi$) groups in a colliding-proton environment must lead to neutral kaons and pions as decay products of the relevant particle resonance. The signature of the observed resonance near 2.60 GeV was the combination $K^0, \pi, \pi, \pi$.

Note also that the so-called (2585) bump listed by the Particle Data Group includes, in its decay, evidence of a proton *P*.

What is so satisfying about this analysis is the fact that the principal elementary particles all have a simple correlation. The pion, in particular, has a specially definitive correlation connected with the feature that the Coulomb energy of the $(P:\pi:\pi)$ group is virtually identical to that of the $(\pi:P:\pi:\pi)$ group. Given $P$, this fixed $\pi$, and full analysis can yield the pion mass energy as 139.568 MeV, in exact accord with its measured value.[16] However, from a qualitative viewpoint the proton-proton collisions at appropriate energy levels must develop pions and neutral kaons, and, as seen from reaction (7) in Table I of Ref. 2, the involvement of muons can produce neutral pions as by-products.

This whole scenario becomes explicable without extending the analysis to involve quark interpretations, but the merit of the result is clear from the additional quantitative determination of the particle masses.

## V. THE JAPANESE *H* QUANTUM

Quite unknown to the author at that time (1966–1969), Hasegawa in Japan had been evolving a theory of the cosmic-based "fireball" in which large concentrations of energy find a way of cascading into a shower of particles seemingly governed by an energy level set by the so-called $H$ quantum. It was in 1970 that the author first became alerted to this activity via the following statement concerning cosmic X rays in a popular science journal:[17] "The main stumbling block to progress is the shape of the X-ray spectrum. This has a curious discontinuity at 20–40 keV, usually termed the kink or break: it corresponds to a break at 2–5 GeV in the parent electron spectrum, which is itself hard to explain."

This was specially relevant because, as the author noted in Ref. 18, this might not only relate to the 2587-MeV $g$ particle, but the lower discontinuity could correspond to the energy associated with the vacuum lattice site. This is smaller than the electron rest-mass energy 0.511 MeV by a factor that is the cube root of that parameter 1843 already mentioned, that is, very nearly 40 keV. Furthermore, this particular vacuum energy quantum is anomalous in mass terms because its effective mass in the virtual muon field is only half that associated with its energy and so would correspond to approximately 20 $\text{keV}/c^2$.

The Japanese $H$ quantum is featured in several papers in Vol. 54 of the Supplement to *Progress in Theoretical Physics* (1973). Fijimoto[19] explains that Hasegawa's "idea was that the present theory of quantum physics and relativity could not be extrapolated into the stratum of the fundamental particles and new laws of physics should be looked for." Taketani *et al.*[20] summarize the Hasegawa proposal of the $H$-quantum hypothesis as follows:

(i) There is an energy quantum with rest energy two or three times as high as the nucleon rest energy.

(ii) The emission of $\pi$ mesons from an $H$ quantum is similar to the meson emission from the nucleon pair annihilation process.

(iii) As the incident energy becomes higher, the nuclear collision produces an increasing number of $H$ quanta, moving more or less along the incident direction.

(iv) The Lorentz factor of motion of $H$ quanta in the center-of-mass system takes discrete values such as 1.5, 6–7, $\approx 40$. Seeing that the set of numbers makes a geometrical series, the relative motion of neighboring $H$ quanta stays approximately constant.

In the 1973 paper by Nanjo and Takana[21] the best value of the $H$-quantum mass energy was said to be between 2.4 and 2.6 GeV. Earlier, in a 1971 paper by Hasegawa *et al.*,[22] the value was quoted as 2.4 ± 0.4 GeV. The referenced experimental work was that of the Japanese and Brazilian Emulsion Chamber Group. Note that this was several years after this author[15] had predicted the $g$ particle at 2.587 GeV from its relevance to vacuum lattice cell structure, gravitation, and meson production.

Tati,[23] in the 1973 group of papers on the $H$ quantum, connects it with a cell structure in space having a unit volume defined in terms of the nucleon mass. He speaks of the restricted number of pairs of particles and antiparticles that Fermi statistics allow to be created in the volume of each cell. Such ideas are not dissimilar to those which had led the author to that 2.587-GeV $g$ particle. Tati's own estimate was stated as 3.0 or 2.5 GeV.

With this background effort concerning the $H$ quantum, it is amazing that so little mention of it is of record in the ordinary particle-physics literature. Indeed, a check on the 5-year Cumulative Citation Index[24] for 1980–84 shows that the basic papers by S. Hasegawa on this subject, published in 1961 and 1963,[25,25] each attracted very few references by authors outside Japan. One of these exceptions was by this author in Ref. 27.

## VI. CONCLUSIONS

Concerning the Japanese $H$ quantum, one can but conclude that, notwithstanding its empirical support, its theoretical basis (in challenging relativity for example) has detracted from its appeal in the U.S.A. and in Europe. Particle-physics research is biased in the direction of testing quantum chromodynamics (QCD) and particle collisions at very high energies, where artificial states such as those of the $W$ and $Z$ bosons and beyond command the interest and the resource. The author's 2.587-GeV $g$-particle prediction, which emerges from a theory of lattice structured space and gives a full account of the gravitational interaction, has been ignored, no doubt also because it conflicts with some aspects of the relativistic doctrine and was not seen as on the mainstream track of QCD.

In conclusion, it is hoped that what has been shown in this paper concerning the intimate correlation between the neutral and charged kaons, the muon, the pion, the tau, and various meson states, including one that must exist at 2.587 GeV, will cause the reader to question some of the orthodoxy of particle physics. The practical outcome from such research can well be confirmation of the author's viewpoint concerning the nature of gravitation and the role played in it by the tau and the 2.587-GeV $g$ particle. By understanding the gravitational interaction, there is potential for harnessing that knowledge to useful ends, a subject which has already inspired the Project G activity mentioned in an earlier *Hadronic Journal* paper.[28]

In a sense, this paper has been written as a plea to those in charge of particle accelerators to seek out that 2.587-GeV resonance.

## ACKNOWLEDGMENTS

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