CHAPTER XXXIX

GENERAL REFLECTIONS ON THE EINSTEIN THEORY

> For, beyond the bounds of science, too, objective and relative reflection is a gain, a release from prejudice, a liberation of the spirit from standards whose claim to absolute validity melts away before the critical judgment of the relativist. (45)MAX BORN

It is extremely instructive to follow the elements of identification as they appear in the evolution of the Einstein theory.

We know that the results of the Michelson experiment which disclosed that light is propagated in all directions with equal velocities for all observers, irrespective of their relative velocities, could not be reconciled with the older mechanics. These results disturbed the physicists profoundly and attempts were made to solve this apparent impasse. In what follows we shall have to analyse incidentally the activities of some of our great scientists, men who have added enormously to our knowledge, and this fact should be appreciated. What we have to say is not intended as criticism—far from it—but simply as a structural and a semantic analysis.

The feeling that we objectify unduly and that we should not use a language of 'is' of identity, that we should use an actional, behaviouristic, functional, operational language and methods, is not new in science, although the need was not formulated structurally, it is true, and therefore it never became a workable foundation. The main successes in these fields were rather accidental, and were the personal prerogatives of those few men whose psycho-logical make-up urged them to achieve. Objectification, which as we know, is a semantic ascribing of *objective* existence and values to terms, was bound to make its appearance somewhere.

This struggle against identification is apparent in all science, but it will suffice to point out the most striking example in the relation of the works of Lorentz and Einstein. Lorentz objectified, Einstein did not. We here come across a tremendous semantic fact which has to do with the *interpretation* of mathematical formulae. Lorentz on elaborate and difficult grounds, connected with Maxwell's field equations, produced what is usually called the Lorentz transformation. He gave it an *objectified* interpretation. Einstein introduced an entirely different fundamental interpretation of the structural *principle* involved. The formulae look alike but they now have different and very simple meanings.

Hertz, whose epoch-making discoveries made wireless possible, advocated long ago what is termed the phenomenological point of view, which in our language is approximately the actional, behaviouristic, operational, functional language and method. In his writings he implicitly refused to use the vicious

term ‘is’ of ‘identity’, and so to objectify his terms, which refusal in picturesque language he expressed as a refusal to legislate about ‘essences’.

The old *E* and *N* language of ‘absolute space’ and ‘absolute emptiness’ were for a long while structurally unsatisfactory. Physicists felt that somehow they could not deal with it, but it never occurred to them that this ‘absolute nothingness’ is objectively meaningless, and that therefore no one can possibly deal with it. Not knowing that, they politely called this non-sense a ‘metaphysical question’ and evaded issues by leaving the solution in the hands of ‘philosophers’, never to be solved.

By now I hope that the reader is quite aware that meaningless problems cannot be solved by any one, and that there are no such things as mesa-physical questions. There may, however, be a question about *enlarging* the domain of physics.

Being forced to abandon this ‘absolute emptiness’, physicists went to the other extreme and postulated some kind of ‘material’ ether. Let us note that such a postulate involves structurally the ‘is’ of identity and objectification. Lorentz in opposition to Hertz postulated an ‘ether’ which was ‘motionless’ in ‘absolute space’. Note that here we have a perfect example of structural *objectification of terms.* ‘Absolute space’ is for him semantically some kind of ‘absolute emptiness’, which, not being satisfactory for the physicist, is filled with some ‘material’, ‘motionless’ ether. ‘Motionless’ is itself an objectification of language, as such a term has here *no* physical or objective meanings at all.

In pursuing the speculations on *objectified terms* (semantic disturbances) it was natural to expect, as the earth is not at rest with respect to the sun, the other planets. , that some ‘ether wind’ or ‘ether drift’ should appear which would make the constant velocity of light impossible for observers moving with different relative velocities. But these structural expectations were not fulfilled. The velocity of light, as shown by many experiments, was a constant for all observers. The ‘motionless material ether’ also became structurally impossible, as might be expected, if we stop objectifying terms.

In 1892 FitzGerald suggested an *objectified* theory, assuming ‘absolute’ ‘length’ and ‘time’ *superior to measurement,* which involve identification and do not allow the use of the actional, behaviouristic, operational, functional attitudes, language, and methods. FitzGerald assumed that every body ‘moving’ with the velocity *v* in the ‘ether’ is shortened in the direction of motion. It should be noted that every mention of ‘shortening’ or ‘contraction’, *presupposes some ‘absolute’* standards of ‘rest’ or ‘motion’ or ‘length’, which do not, and cannot, exist outside of our skin, but are only semantic disturbances, inside our skin, which occur when we identify and ascribe *objective* existence and value to *terms.*

How deeply and completely these objectifications permeate our daily and scientific lives is best shown again in the case of Lorentz. Even in 1917, in his Haarlem lectures, he expressed structural hopes that a ‘material’, ‘substantial’ ether can be preserved, that ‘space’ and ‘time’ can be sharply separated, and that ‘simultaneity’ can have an absolute meaning.

In the *Theory of Relativity* of Whitehead, and in some others writers who deal with the theory of Einstein, and particularly in all critics of Einstein, we find a similar objectification of terms.

They still *feel* the older *E* and *N* 'absolute emptiness', 'absolute space', 'absolute time', to which *terms* they ascribe structural objectivity. In such works the term 'contraction' is used frequently.

Let me recall the mechanism of objectification. If we do not reject explicitly and implicitly the 'is' of identity, we automatically identify different orders of abstractions and ascribe objective characteristics to terms. Thus the term 'time' which represents a label for a feeling inside our skin, is given an objective evaluation. If 'objective' it must have a 'property' of 'simultaneity', a semantic process taken over from comparing two objective sticks when the two ends are made to coincide. On the objective external level, we never deal with 'time' but we simply *compare processes.* When we select an arbitrary unit-process on the objective level, whatever we might *say* that it 'is', well, it *is not,* and the difficulty found exclusively in the use of the 'is' of identity.

If we abandon entirely the 'is' of identity, we stop objectification, we do not ascribe objective existence and values *outside* our skin, to terms and semantic reactions *inside* our skin. But then of course we have to change the *structure* of our language; as otherwise the old *s.r* will continue to play tricks on us. An actional, operational, functional language of *order is* the structural solution of our semantic difficulty.

If we objectify 'space' into 'absolute space', we must objectify it as 'absolute emptiness' for only such an 'absolute space' can be at 'absolute rest', that is, static in the *E* or *N* sense. Similarly only objectified 'time' can have the 'property' of 'absolute simultaneity'.

If we realize that these 'absolutes' are only the semantic objectifications of terms, (where the activities of the lower nerve centres are structurally ascribed to the activities of the higher nerve centres and vice versa), we begin to differentiate between different order abstractions, and to keep them differentiated. In terms of our structurally new language we become 'conscious of abstracting', and then habitually *and unconsciously* use the behaviouristic language and methods of *order.*

If we picture this 'absolute emptiness' or 'absolute nothingness' (which cannot be done successfully, as it has no meaning), and try to compare it with a plenum, or 'fulness' (a cloud of smoke, for instance), we see at once that only this 'absolute emptiness' can be static, homogeneous. , a condition that is impossible with a dynamic fulness.

Perhaps we can now appreciate the tremendous semantic significance of the Einstein theory, which introduces structurally a *non-objectified,* human, sane attitude of proper evaluation toward this world. We should not be surprised to find that a $\overline{A}$-system which is an inevitable general structural concomitant of the $\overline{E}$ and $\overline{N}$ systems of geometry and physics should *formulate as a general structural and semantic issue* what the $\overline{E}$ and $\overline{N}$ systems have *done* in their special fields, without such general formulation.

From our structural point of view there is no retreat; the Einstein work is irreversible. In the younger scientists of today the non-objectified attitude toward *terms* of 'space' and 'time' is already an accomplished semantic fact, entirely independent of what future experiments may show. For experiments can never justify identification, and so can have no detrimental effect upon this fundamental and most beneficial structural, linguistic, and semantic revolution. Our $\overline{A}$ task was to formulate these issues *in general* so as to make us conscious of them; and I assume that it is at this semantic point that the tremendous value of Einstein's work will manifest itself in life. Indeed we shall see later on in this volume that the newer quantum mechanics, which have begun to spring up rather rapidly, is made possible only by the semantic background imparted *unconsciously* (as yet) to younger physicists by the Einstein theory. It is my hope that the present work may make the above issues *conscious*, and so enable us not only to impart this semantic attitude more easily and with less labour but also to benefit by them more universally in our *daily life*. The problems of science and life do not differ in this respect. In both we are equally hampered by semantic disturbances, 'emotional stupors', identification, and similar difficulties, the elimination of which means better adjustment for all of us, as well as swifter progress in science.

A study of the history of science shows how slow and painful scientific progress has been. Now we begin to see why. 'Geniuses', as history shows, are men who at least in some fields are freer from identification and false evaluation than others. They are not hampered to a similar extent by 'emotional stupor'; hence they can evaluate the old *anew*. Lorentz, for instance, produced the formulae, but his objectifications *prevented* him from evaluating properly the new formulae. As a fact of history the formulae of Lorentz were discovered by Voigt a number of years before, but identification made impossible the evaluation of these formulae, and so *delayed* the discovery of the Einstein theory. This factor of identification can be found all through recorded history as a retarding semantic blockage.

If we could find methods of eliminating these semantic disturbances, an extremely hampering, paralysing psycho-logical factor would be eliminated, and 'geniuses' could be made the rule rather than the exception. Let me say again: in the old days morons were made and geniuses were born; in the new days, perhaps, this can be reversed, and *morons will be born but geniuses made.* We witness something of this kind among the younger post-einsteinian physicists, where the number of 'geniuses' is growing rapidly, in spite of the fact that the above structural issues are not as yet consciously applied in general education. The secret of creative work is freedom from structural bondage, and particularly the structural semantic bondage of words.

The reader should not assume that the few simple structural explanations given in this book exhaust the Einstein theory. I have not even attempted to summarize the theory; I have only given a few semantic facts, which belong to general semantics and to the theory of knowledge. The Einstein theory is

indeed such a tremendous structural linguistic achievement that quite probably its full semantic significance and meanings will not be worked out for many years to come. We have given here only the minimum of explanation necessary for our special purpose.

The historical development of a theory has usually little to do with the semantic importance of the theory or its deeper meanings. The constancy of the velocity of light for all observers, which started the ball rolling, was an historical beginning and it served its purpose well, though the objectified 'contractions' and formulae of FitzGerald and Lorentz also did their share, as they helped Einstein and Minkowski to produce their epoch-making structural challenge to old prejudices such as 'absolute space' and 'absolute time', which were semantic remains of a primitive, perhaps pre-human, remote past. Once this is accomplished, no matter how, there is no return possible. Of physical structural facts, all that we need is the *finite* velocity of the propagation of events,* which as we already know involves far-reaching structural and semantic issues. Of the psycho-logical issues involved, we need only to eliminate semantic disturbances which still occur when we copy animals in our nervous processes and do not discriminate between different orders of abstractions—which animals do not recognize. This elimination can be done by training in the $\overline{A}$ methods explained before, with the net result that we become 'conscious of abstracting' on different levels and so can instinctively and by feeling discriminate habitually between orders of abstractions, which structurally and semantically could not be done by the old disciplines.

The theory of Einstein has manifold applications but we need only mention a few, which we shall utilize later on.

First, and above all, there are no possible 'absolute' meanings to 'space' and 'time', beyond the relations established by measurements. The structure of our language involving 'space' and 'time' should be similar to the structure of experimental facts, which ultimately show the impossibility of sharply dividing them.

If any one challenges this statement, he could not *a priori* be criticized. Such criticism would be entirely against the whole tendency of the present work. But such a person might be approached with no little curiosity and expectation. He could be asked: 'You claim that you can absolutely divide

* 'But', Some reader may ask, 'though you assume a finite velocity of propagation, may it not happen that some day an "infinite" velocity will be discovered ?'
Such a question would show that the reader has missed the point in the present work. We are confident in saying that an 'infinite' velocity has no meaning, and that no matter what we discover, this will never be discovered. This becomes still clearer if we use the differential *definition* of 'velocity'. Velocity is defined as the 'time' derivative of 'space' travelled. If 'time' is taken as zero, or if we have 'no time', there can be no 'time derivative' by our very assumption, and, therefore, no 'velocity'. There is, therefore, no danger that we shall ever discover in the actual world an 'infinite' velocity.

"space" and "time" on the objective level. That would be an epoch-making structural discovery. *Please demonstrate how to do it.*'

The fact is, of course, that he cannot demonstrate the process, because he refers to identifications inside his skin; yet he is claiming to be able to show it *objectively* outside his skin. That ends this problem.

While speaking of Einstein's Theory, it will be well to mention a few of the many structural differences between the older newtonian and the new einsteinian mechanics.

In the *N*-system, relative velocities were simply added $W_N = v + v'$. In the einsteinian system which we will denote by $\overline{N}$, it is not so structurally simple. We must introduce the finite velocity of propagation of our signals, which *alone* give us the data, and so

$$W\overline{N} = (v+v')/(1+vv'/c^2)$$

The above formula involves the remarkable constant, *c*, the velocity of light. If we assume in the above formula that our velocity *v'* is equal to the velocity of light, *c*, we would have

$$W\overline{N} = (v+c)/(1+vc/c^2) = (v+c)/(1+v/c) = c$$

This means that the addition of some velocity to the velocity of light does not alter the velocity of light, which thus appears as a *limiting* velocity.

This applies to the difference of velocities where

$$W\overline{N} = (v-v')/(1-vv'/c^2)$$

Let us here give an example of Eddington's. Let us assume two relative velocities each differing by only 1 km./sec. from the velocity of light. Let us say that one is 299,999 km./sec. and the other 300,001 km./sec. Now let us calculate the relative velocity. This relative velocity will be found to be 180,000,000,000 km./sec. For in our formula $v-v' = (c+1) - (c-1) = 2$, and

$$(1-vv'/c^2) = 1-(c+1)(c-1)/c^2 = 1-(c^2-1)/c^2 = 1/c^2,$$

whence $W\overline{N} = 2/(1/c^2) = 2c^2 = 2\times300{,}000\times300{,}000 = 180{,}000{,}000{,}000$.

We see that a particle which might try to overtake light by having a velocity of one km./sec. greater than the velocity of light could never succeed. When the velocity 299,000, for example, was reached, the particle would find itself further away from its goal than when it started.[1]

Similar general considerations apply to mass. If we designate the mass of a particle at rest by m_0 its mass in motion

$$m\overline{N} = m_0/\sqrt{(1-v^2/c^2)}$$

As the denominator is smaller than unity the mass in motion, $m\overline{N}$ is larger than m_0, the mass at rest. In the limiting case, when the velocity would become equal to *c* the denominator would become zero and our mass $m\overline{N}$ would tend

toward infinite values, which is another way of saying that it is physically impossible.

In the *N*-system we had two kinds of energy; one was called *vis viva* or kinetic energy, and was represented by $T=mv^2/2$; the other was called potential energy, or capacity for work, and was denoted by *U*. The law of conservation of energy in the *N*-system was expressed by the statement that the sum, $T+U=E$, or the total mechanical energy of a system remains constant (zero variation) during the motion of the body.

We see that as the above formula involves the terms *m* and *v*, the older formulae for energy must be altered, especially since they do not survive a Lorentz-Einstein transformation. It is found that

$$T\overline{N} = c^2(m-m_0), \text{ or } m=m_0+T\overline{N}/c^2,$$

which formula appears rigorous as a definition of kinetic energy even if members of order higher than the second are taken into account. In words, the mass in motion differs from mass at rest by the kinetic energy divided by the square of the velocity of light.

This expression suggests immediately that the static mass, *m*, is similarly related to the energy content in the body at rest. Generalizing our results we would have $m=E/c^2$, an equation which holds generally between mass and energy. This fact has been called by Einstein the law of the *inertia of energy*. It has been verified repeatedly by experiments, and is one of the most striking structural results of Einstein's theory. The above statement means that the two fundamental notions of 'mass' and 'energy' are equivalent and thus we have a clearer vision of the structure of 'matter'. The two older structural laws of 'conservation of matter' and of 'conservation of energy' become fused into one. Mass becomes structurally and verbally nothing else than energy concentrated at a point, and it appears as a form of energy manifestation.[2]

The above considerations have also led to a revision of our structural notions about 'energy' which we do not need to explain here. Suffice it to say that the old 'potential' energy is not associated structurally any longer with any features of this world. It can be made to vanish by a proper selection of co-ordinates, hence it is no longer considered as energy of any kind.[3]

With the Minkowski world we became acquainted with a new *language* which represents structurally more nearly the facts of experience (lower order abstractions) and shares the structure of our higher order of abstractions. So we have the language of 'space-time'. How about 'matter' ? The bumping against something hard is not to be disregarded. True, *we need a language of new structure, but that is all.* In the Einstein theory, 'matter' of course is not treated separately as such. It is an offspring of the field, and is connected with the curvature of the world. The reader should not be surprised to find that the Minkowski world, which has accelerations, must be curved in this structurally new form of representation.

We have already defined a most fundamental entity called 'action'. Naturally in a space-time manifold, energy multiplied by 'time' should be a more fundamental entity than energy, and we call it 'action'. When we speak about

some continuous material present in ‘space’ and ‘time’ we speak in terms of density. Density multiplied by a three-dimensional volume of ‘space’ gives us mass, or what appears as its equivalent—*energy.* From a four-dimensional, or space-time point of view, density multiplied by a four-dimensional volume of space-time gives us action. We see that the multiplication of density by the three dimensions of ‘space’ gives us mass or energy. A fourth multiplication by the dimension of ‘time’ gives us mass or energy multiplied by ‘time’ which becomes action by definition. It is obvious that, structurally, action must be more fundamental than the older quantities.

In terms of curvature, action represents the curvature of the world, because where we find ‘action’, we also find ‘matter’, acceleration, gravitation, .[4]

‘Action’ is fundamental, because structurally in a four-dimensional metrical manifold it takes the form of the simplest integral *invariant* that can exist at all. On this form of action Maxwell’s electromagnetic theory is built. The quantity action appears as a pure number,[5] a unique, specific relation which conditions structure.

We should expect that the action represented by the number 1 would be most interesting and would eventually represent the indivisible atom of action. The modern quantum theory seems to favour such a point of view.

When we encounter a pure number having such crucial significance in this world we should not wonder that such a number intrigues us. As yet it is impossible to state that action cannot have fractional numbers. What, then, would the action represent ?

Eddington suggests that the number may represent a *probability* or some function of a probability.

We combine probabilities by multiplication, but we combine actions in two regions by addition. We see, therefore, that the logarithm of a probability gives the function indicated and Eddington suggests the provisional equivalence of action with the negative of the logarithm of the statistical probability of the state of the world around us. Such a suggestion is extremely appealing and important because the principle of *Least Action* can be stated as the principle of *greatest probability.* The laws of nature appear to be such that the actual state of the world is represented by that which is statistically the most probable ![6]

That such structural conclusion can be drawn at all is of tremendous semantic importance for us because, as we are *abstracting* in different orders all through, the only appropriate language in which we can eventually hope to speak correctly, is the language of probabilities, statistical averages, .

Action is one of the terms of pre-einsteinian physics which has survived unmodified, the only other one being entropy. The law of gravitation, the laws of mechanics, and the laws of electromagnetism, can all be, not only summed up, but also deduced, from a single principle of least action. This important structural unification was accomplished even before the advent of the einsteinian theory, and only the addition of gravitation to this list is new.[7]

In this brief structural and semantic survey we have had neither the opportunity nor the necessity of analysing the general theory of Einstein, which embodies and unifies most of the laws of mechanics, that of gravitation included.* In this unification lies the unrivalled grandeur of the theory. As we shall see later, the newer quantum theories have been already very much influenced by the Einstein theory. As all possible theories are dependent on *human ingenuity* and never can be the events themselves, we can rest assured that once freed from 'emotional stupors' and semantic disturbances, the world will not be long in producing a whole structurally unified system of science.

In our discussions we deal with 'apparent', 'real', 'actual', and similar *m.o* terms. We should recall that mathematics is *exclusive* in one respect; namely, that it has no content. It is entirely a product of higher abstractions created by definition from undefined terms. We have seen that mathematics must be considered as a language of special structure which is, however, similar to the structure of the world around us.

Our daily *A* language, among others, being based on the 'is' of 'identity', can never give a structurally satisfactory picture of this world or ourselves, but actually prevents such an achievement. Having abandoned a language which leads to identification, we shall be able to apply a new language, with new structure, by which we achieve better means for representing the events around us. From this point of view, mathematics and our daily language do not differ. Terms, being not the things they represent, must by necessity be creatures of definitions and undefined terms. The solution of many baffling semantic problems is found in the *structure* of a language which involves different semantic and unconscious attitudes.

* In fact, a few months ago, Einstein and Mayer succeeded in reducing the laws of gravitational and electromagnetic fields to a single basis. This was accomplished by the aid of a very revolutionary mathematical discovery that it is possible to introduce into a 'space' of *n* dimensions, vectors with *m* components. Although at present the results of the quantum theory are not included in this theory, there is no doubt that shortly, because of this mathematical discovery, these will be included in a *generalized* theory of relativity.