IMPERFECT PICTURE-THE BEGINNING OF A FINAL SYNTHESIS

In this chapter is given, almost without abridgment or editing, a draft, begun February 1 1952, which appears to be "the most fundamental part which you have never seen" (page II) and about which alone Jessup felt some complacency shortly before his death: the earlier theoretical work he then regarded as "entirely inadequate." This draft is the beginning of an attempt to rewrite an earlier draft paper summarising much of the work outlined in Chapter XII, and in order to minimise criticism from the accepted point of view he had fortunately begun with the cosmological picture which he later hoped to justify.

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PRELIMINARY NOTE ON THE MASS AND MAGNETIC MOMENT OF ELEMENTARY PARTICLES

SECTION I. FUNDAMENTAL CONCEPTS OF SPACE AND TIME.

Properties of the Space-Time Continuum: Bosons and Fermions.

In what follows let us for the present assume that space-time is adequately represented by the heuristic (if not the ideological) conception of the special and general theories of relativity.

Let us consider every elementary particle or photon possessed of spin as rotating about its z-axis. Let us also consider the particle to possess an inherent asymmetry in space-time, which results in departure from the spherical. We shall not be dealing with point particles, though nothing for the present precludes us from dealing with point charges. Nor would it be just immediately to oppose a formal opposition based on relativistic conceptions to this conception of a particle possessing extension in space-time, since the particle may only be capable of interaction with the field, and the field may be generated by a point charge (for even in the case of electrically neutral particles their neutrality may be ascribed to a charge rapidly oscillating from positive to negative: we shall in fact show that this applies to the neutron, and probably to the neutral meson as well).

We may, if we like, imagine the sphere as compressed in the direction of the future and elongated in the direction of the past; this however is a completely arbitrary conception, which is only taken as an example of a type, and has no particular bearing on the numerical relations which we shall derive from our analysis of the fundamental conception of a space-time asymmetry.

Next let us suppose that the particle is capable of emitting electromagnetic radiation in the shape of the field only once per revolution, or once for a number of revolutions; then it will be a boson. If however it is able to radiate electromagnetically once every half revolution, it will be a fermion. In principle, we consider every material particle to be capable of radiation every half revolution, unless the field is blocked by processes to be subsequently investigated.

Now let us attribute a peripheral speed of rotation to each particle equal to $\frac{\pi}{2}c$, where c is the velocity of light. Then every particle moving with velocity less than c in a universal frame of reference will be at some spot at the half cycle which is not an even multiple of its diameter, counting zero as of even parity with respect to the final point of emission. Its total wave function must therefore be anti-symmetric, and we see that all fermions must in fact be anti-symmetric. If however we consider a particle moving with the velocity of light, at every half period, the emitting point will either be at the same spot at which the first emission occurred, or two diameters away: it must therefore be symmetric, and will be a boson. All bosons which are not compounded of an even number of fermions must therefore be symmetric and move with the velocity of light, or in other words they must be photons (for we shall in fact show that

bosons such as 1T mesons are really compounded of an even number of fermions, and so of course are nuclei composed of an even number of nucleons).

Now suppose we let our particle rotate in space-time so that the time axis is one of the axes of the plane of spin; if we fix the velocity c along the other axis (the x-axis), we shall find that the time axis has been reversed if the motion of semi-rotation and the velocity are opposed; and if we take the resultant of the two axes opposed by 180° C. we shall find that we have rotated our time axis by 90°. Similarly if we take the opposite half rotation we find that the time axis has been rotated through 90° with respect to the universal frame of reference; and the same will hold for any observer stationary in his frame of reference if the velocity c be fixed with reference to this frame. We therefore see that a body moving with the velocity of light with respect to an observer in a given frame of reference will have its time axis (and therefore also its x-axis of space) rotated through an angle of 90° with respect to the observer's frame of reference. If to the heuristic conception, abundantly vouched for by experiment, that the velocity of light is constant for all observers whatever their relative motion, we add the evident consideration that space is isotropic with respect to the x-axis, and postulate (as we shall later prove) that the time axis and the space axis can never be rotated through more than 90° with respect to any frame of reference, this will automatically entail the consequence that no linear velocity faster than that of light can exist with respect to any frame of reference, and that light (photons) must proceed with this same velocity with respect to every frame of reference.

To demonstrate this, we have to establish the following:-

(a) That the time and the x-axis of space cannot be rotated through more than 90° with respect to any observer: there can then exist no measurable velocity exceeding that of light.

(b) That there can exist no (observable) privileged frame of reference in the Newtonian sense; for this the velocity of light must remain constant with respect to the frame of reference of any observer, whatever his relative motion. We shall prove both these points in the next two sections. Later we shall show that (b) can be extended to the more general statement that every observer carries his space and time with him, and makes all measurements as if he himself were situated in the (imaginary) privileged Newtonian frame of reference.

If we accept postulate (a) and also postulate (b) in its widest sense, then, as Einstein himself has shown, we have all the prerequisites which render the special theory of relativity inescapable: there is no other logical interpretation of space-time compatible with these postulates.

Equations Defining the Special Theory of Relativity.

These are well known, and no new presentation could in any way alter them. We propose however to consider a new formulation which serves as a convenient adjunct, 'and which lays special stress upon the orthogonal rotation of the (x, t) axes for photons which has been specified in the preceding section. Before we do this, there is a further point which it is necessary to clarify .The rotation which has been defined in the preceding section must of course be considered with respect to a plane which is held motionless in time: the abstractions which impercipience of a fourth dimension forces on all observers. If there is movement along the time axis equivalent to c, then we shall get the usual relativistic picture, with the angle of the light cone set at 45°, and the true rotation will be 45° against an apparent rotation of 90°, This picture is equally cogent, and perhaps more easily visualised, if we consider the plane of rotation to lie wholly in space, as indeed occurs, as we shall see; for all material bodies other than the basion and mesons. We may most easily numerise our picture thus restricted by percipience in which the plane of rotation is kept (apparently) motionless, by substituting for the relativistic angle θ, the angle θ' such that $\sin\theta' = v/c$. Then it is open to inspection that the rotation resulting from our restricted percipience will result in the substitution

of an angle cos θ' for the relativistic factor $k = \left(1 - \frac{v^2}{c^2}\right)^{1/2}$: measuring rods in space will contract by a factor equal to cos θ' and the time interval increase by a factor equal to sec θ' in a frame of reference moving relative to the system of reference in which the observer is located. We must however always remember that since time is imaginary, and since the axis of time must always therefore appear "imaginary -orthogonal" to our axes of space (for this construction is implicit in the use of the operator i which is our only mathematical tool for investigating the imaginary), we can perform no operation involving the compounding of two rotations (such as the addition theorem of velocities) without resubstituting i tanθ for sin θ'.The addition theorem for velocities will therefore read :

$$\text{Sin}\,(\theta' + \phi') = \sin\phi' + \sin\phi'/(1 + \sin\theta'\sin\phi') \qquad \text{(I)}$$

(and not $\sin\theta'\cos\phi' + \cos\theta'\sin\phi'$!)

We know that for any angle exceeding 90° cos θ' must become negative. This is physically impossible; and indeed the zero value obtained for cos θ' when θ' = 90° clearly indicates tbat we have reached a limit-we have replaced the material fermion with the immaterial photon. Cos θ' therefore cannot exceed 90° and no measurable velocity can exist greater than that of light.

As we might expect, the special theory of relativity underlines the limiting value of the velocity of light, for, since mass varies as sec θ', mass would become infinite and the universe itself disrupt if two material bodies could be given a realtive velocity equal to c.

Equivalence of All Frames of Reference.

For the time being, let us restrict our picture to the present and the past; an enquiry into the future will follow later. We can however, if we deal with a sufficiently small volume of space in the absence of a gravitational field, consider the three dimensional volume of space not only to be subject to Euclidean geometry, but to constitute a three-dimensional interface between past and future in our world of four dimensions (this is self evident if we are dealing with an individual particle--say an electron-which can transmit no light signal to itself). In this most restricted case, which can be justified inasmuch as our whole enquiry is for the present restricted to a single particle, we may set up a space axis stretching on both sides of the origin, and a time axis, and we may label the phases of the three axes, + I and -1 for the two space axes set at 180° with respect to each other, and i for the time axis at 90° to both space axes. Then we can construct an equation :

$$Cos\ p\pi + i\sin\ p\pi = f_{(i)}\left[(-1)^p\right]$$

with -1 < p < 1, and with p and i both positive. Let us fix the axes of space and time so that on the time $f_{(i)} = 1$; then $f_{(i)}(-1)^p = i$; and on the space axis $f_{(i)}(-1)^p$ will equal -1 and 1. Let us fix θ' (and hence v/c), by making θ' = $\pi\left(\frac{1}{2} - p\right)$, and let us further fix π for space as the direction in which the observer is free to move, and 17 for time as the direction in which he is free to measure (always remembering that the measurements he will make must remain imaginary). Then we shall find that the real part of $\left[(-1)^p\right]$ is equal to cos pπ and is hence equal to sin θ', and the imaginary part of $\left[(-1)^p\right]$ is equal to i sin pπ and is numerically equal to cos θ' with a positive sign.

Let us adopt as a first principle that every real body in space must have a real part in the term $f_{(i)}\left[(-1)^p\right]$. Then it follows that for θ' = 0 there is no real part, there can therefore never be an existing observer who is motionless in space or in an absolute frame of reference, and we

have thereby, at least in the absence of a gravitational field, excluded the existence of a privileged observer with a privileged frame of reference. He can exist no more than a material body can attain the velocity of light. But a gravitational field will only distort space and render it non-Euclidean; and since the privileged frame of reference of Newtonian mechanics must be Euclidean, we have also excluded a privileged frame of reference in the presence of a gravitational field. Here we have of course made use of the general theory of relativity.

It is trivial to replace $f_{(i)}\left[(-1)^p\right]$ by $e^{ip\pi}$, but we can then replace equation (2) by the simple statement that all motion in space and time can be represented by a vector diagram of $e^{ip\pi}$ in which the appropriate value of p, where $-1 \leq p \leq 1$, has been inserted; while the axes of space-time are located by those values of pπ where cos pπ or sin pπ vanishes. The space axes correspond to the sine vanishing while the time axes correspond to the cosine vanishing.

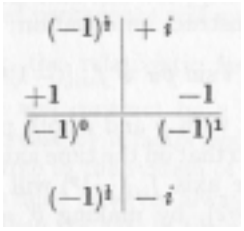
Incorporation of the Future into the Vector Diagram of $e^{ip\pi}$.

To complete our picture of reality we must not only incorporate the past into our vector diagram, but also the future. To achieve this, we should rewrite equation (2) as follows :

$$Cos\ p\pi + i^{\pm 1} \sin p\pi = f_{(i)}\left[(-1)^p\right] \text{..(2a)}$$

where p bears the same sign as the index of i.

We can supplement this equation with the following diagram.



The first question which arises is : what is the reciprocal of i which we should adopt in diagram 1 ? If we square the reciprocals of +1 and -1, and take the square root, we know that we must replace the same sign as in the reciprocal to obtain the correct algebraic answer. The rule is clear: if the sign is definite, we must maintain the same sign. But i is not an algebraic quantity, but an operator with indefinite sign (as can be seen from the fact that its square is negative, since a negative value can only be obtained by a multiplication of a positive by a negative, or an indefinite sign by its inverse $\left[\pm \times \mp\right]$). We should therefore be able to say that the reciprocal of i is either i or -i (it will indeed be seen that squaring either value gives $i^2 = -1$).

In the diagram we have constructed, we shall choose the negative value, since this will give us perfect axial symmetry (i being balanced at 180° by -i, and $(-1)^{\frac{1}{2}}$ by $(-1)^{-\frac{1}{2}}$, for the time axis of past and future, just as we have +1, and -1, $(-1)^0$ and $(-1)^1$ for the two space axes of approach and recession with respect to the unknown displacement of the observer along the x axis (for at every moment of time he must be moving along his x axis), or the known displacement of a body moving relative to him.

We can therefore draw up four subsidiary schemes, using the possible variants of our axial representatives of space-time symmetry.

(a) Using i for the past and -i for the future, we find the past stretching out in uniform steps measured by i, separated by the present from the future stretching out in uniform steps measured by -i.

We shall subsequently show that each step can be associated with one quantum.

(b) Using i for the past and its reciprocal for the future, we find the past stretching out in uniform steps measured by i, separated by the present from the future, which is now one step thick and re-entrant upon itself.

(c) Using -i for the future and its reciprocal value for the past, we now find the past one step thick and re-entrant upon itself, while the future stretches out in uniform steps measured by-i.

(d) Plotting both past and future in reciprocal values, we now find both past and future one step thick and re-entrant upon themselves.

We shall return later to the significance of these steps and their respective inversions.

Further Geometrical Considerations of Fundamental Conception of Space-Time.

We may further clarify our geometrical conceptions by constructing the diagram as shown in Fig. 13.

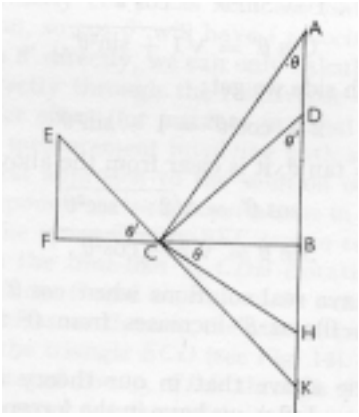


FIG. 13

Let AB represent the life line of a body, 5, at rest in the universal frame of reference, and let AC represent the life line of a body SI moving with velocity V relative to S. Then the angle CAB is the relativistic angle θ, and the angle CDB, our derived angle θ', but now so constructed that *i* sin θ' = i tan θ. We see that SI has its x axis rotated through the angle θ' from CF to CE, while the orthogonality imposed on *i* forces the rotation of the time axis from CA to CD.

All radical values will have attached to them some function of Applying the theorem of pythagoras to Fig. 13 we find:-

$$AC^2 = AW^2 + BC^2 .$$

and $$CD^2 = BC^2 + BD^2 .$$

But i is associated with AC, CD, and AB and BD, giving:-

$$-AC^2 = -AB^2 + BC^2$$

and $$-AC^2/AB^2 = -I + \frac{BC^2}{AB^2}$$

i.e. $$-\mathrm{Sec}^2\theta = -1 + \tan^2\theta$$

or $$\mathrm{Sec}\theta = \sqrt{1 + \tan^2\theta} \ .$$

By adding 2 to each we get

$$2 - \sec^2\theta = I + \tan^2\theta .$$

We also find for the smaller Δ involving θ^1:

$$-CD^2 = BC^2 - BD^2$$

or $$-1 = BC^2/CD^2 - BD^2/CD^2$$

or $$-1 = \mathrm{Sin}^2\theta' - \cos^2\theta'$$

i.e. $$\mathrm{Cos}\ \ \theta' = \sqrt{1 + \sin^2\theta'}.$$

By adding 2 to each side we get :

$$2 - \mathrm{Cos}^2\,\theta' = 1 - \sin^2\theta'. \ .$$

Now since sin θ' = tan θ, it is clear from the above that:

$$\cos\theta' = \sqrt{2 - \sec^2\theta}$$

$$\mathrm{Sec}\,\theta = \sqrt{2 - \cos^2\theta'}\ .$$

These equations have real solutions when cos θ' = sec θ = 1 (and therefore θ' = θ = 0) ; as θ' increases from 0° to 90°, θ increases from 0° to 45°.

We see from the above that in our theory as fully developed from equations (2) and (2a), we have in the foregoing substituted the relationship *i* sin θ' = *i* tan θ from original relationship sin θ' = v/c. If we ask how we can then substantiate the usual formula for cos θ' $\left(= \sqrt{1 - \sin^2\theta'}\right)$, we must have recourse to the following considerations.

We can replace $f_{(i)}$ in our original equation (2) by:

$$1^{(½-p)} \sin p\pi - 1^{(½-p)} \mathrm{Cos}\ p\pi,$$

when we find that

$$e^{ip\pi} = -1^p\left(1^{(½-p)} \sin p\pi - 1^{(½-p)} \cos p\pi\right) = \cos\ p\pi + i \sin\ p\pi \quad (2b)$$

This analysis has the advantage of introducing the index (½ - *p* = *θ'*) directly for both sin *θ* + cos *θ* .We can then regard the indices inside the bracket as representing the angle when time is fixed as the zero axis, while the whole expression represents the angle measured when space is fixed as the zero axis. We have in fact transposed from a time axis to a space axis, from a time representation to a space representation when we pass from the bracket to the complete expression.

If we return to Fig. 13, we see that although in the Δ CDB we are dealing with i sin *θ'* and cos *θ'*, in the Δ FEC, we are dealing with sin *θ'* and i cos *θ'*, and that the two Δs are at right angles to each other. It is obvious that the Δ CDB defines the time representation, the Δ FEC the space representation. We can also see from our figures and the construction of our equation (2b) that whatever representation we take, either the sine or the cosine will be multiplied by i, but never both, and that, sin *θ'* is the complement of *p*, in every representation *θ'* will always have i attached to the sine or cosine inversely to *p*. Now we have started from the fact that sin 8' had i associated with it in the time representation, which accords with the fact that i is associated with sin p in the space representation; similarly cos p has no i associated with it in the space representation, so cos *θ'* will have i associated with it. We cannot measure sin *θ'* directly, we can only calculate it; but we can measure cos *θ'* directly through the relativistic connection to the longitudinal Doppler effect (for instance in canal rays). When we do this we make a measurement involving both space (λ) and time (ν). To make a first approach to the solution of

our problem we must therefore compound their representations in the sense that we measure sin θ' in the space like Δ FEC (space covered in a given time) and cos θ' in the time-like Δ CDB (rotation of the axis of time). We then get cos θ' and sin θ', but we cannot equate cos θ' to sin θ' unless we measure them in the same triangle. To do this we must construct the triangle ECD (see Fig. 14).

We have now rotated the Δ CDB through θ' to ECD. This picture has a still more fundamental justification, for we have excluded any real observer whose time axis is DB and whose space axis is CB, and therefore all actual observers will have i associated with EC as well as with DE and DC. If we construct our pythagorean squares, we shall then get $(i\text{ED})^2 = (i\text{EC})^2 + (i\text{DC})^2$, or if we divide through each side by the hypotenuse (remembering always to divide the hypotenuse by itself), $1^2 = \sin^2\theta' + \cos^2\theta'$. Again if we substitute the Δ CDB for the Δ EDC, we shall still get iCB (instead of CB, since there is now no actual line CB which has no i associated with it). We are justified therefore in our use of either the Δ EDC, or the Δ CDB (remembering always that its space axis can never be the absolute space axis) as a fitting Δ to measure both space and time, both λ and ν. Whichever way we like to carry through the operation and whichever triangle we use, we shall find that $\cos\theta' = \sqrt{1 - \sin^2\theta'}$, and our original approach will be justified. This last approach is particularly instructive, for we see that for an observer enjoying the Newtonian preferred frame of reference, we should have to write: $\cos\theta' = \sqrt{1 + \sin^2\theta'}$. The fact that all physical measurements always give $\cos\theta' = \sqrt{1 - \sin^2\theta'}$ is therefore sure to be in itself a conclusive argument, not against the existence of such a frame, but against the possibility of an observer occupying it.

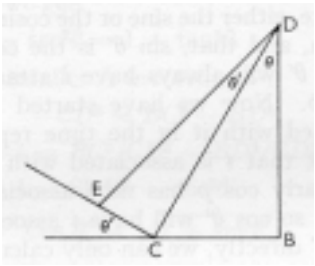


Fig 14

Finally it is also instructive to analyse the space-time geometry using the angle θ instead of the angle θ'. We then substitute the objective picture (which we shall show to be compatible with the picture of a three-dimensional ether film) in which it is only the axis of the subjective space (electrons, nucleons, etc.) which rotates, while there is only one immutable axis of space: we have in fact transposed from the individual frame of reference of the observer to the universal frame of reference from which he is excluded. We must therefore always deal with i tan 0. We see then that sec θ will always equal $\sqrt{1 + i\tan^2\theta} = \sqrt{1 - \sin^2\theta'}$.

This is equivalent to saying that S^1 is in motion in the absolute frame of reference; he measures AH as if it were DE, and hence DK (see Fig. 13). But that is precisely the same thing as saying that the observer stationary in the absolute frame of reference has made the same measurement of the moving observer's time as the moving observer has made of the stationary observer's time: once more we are reduced to the fundamental postulates of the special theory of Relativity.

Transference of our Fundamental Equations to an Expanding Universe.

All too little is known about the universe except that it is expanding. Starting from this fact and superimposing it upon our fundamental equations, we shall examine several solutions in detail, and determine as far as possible their repercussion upon the structure of space-time.

Let us first of all examine the solution of an expanding four- dimensional hypersphere, where the time axis is always in a radially expanding direction. This hypersphere may be taken to represent the "ether" of classical electromagnetic theory. We have however the choice of locating the ether in the past in which case we have a solid sphere expanding into a void, or in the future, when the past will be a hyperspherical hollow void, and the ether will represent the future. In the latter case, we shall probably be correct in assuming that we are not dealing with an ether infinite in spatio-temporal extent (except for the small void representing our universal part). We shall therefore have to restrict the ether to an ever-expanding hollow hypersphere, whose four-dimensional or (future) temporal extent is perpetually diminishing; when this has been sufficiently reduced in such a scheme the universe must cease to exist, since the future will be reduced to zero and the ether will have disappeared with the future.

Whichever version we choose, the present will remain a three-dimensional (spatial) interface between the past and future, and there will be no ether in space-time, but only in time, past or future.

Basing our conceptions on this picture, we should expect the fundamental laws of nature to cover both the concepts of a void and those of a material substance in such a way as inextricably to blend the two. It is ideologically self-evident that the conceptions of a void are synthesised in the special theory of relativity, for all must be relative when nothing exists and when all values are imaginary. We might however expect Newtonian laws to exist in the ether, to which on these conceptions we must allot a corporal entity. If this is so, and if we imagine photons and electrons as waves or disturbances in the ether reacting on our spatial interface, they must obey material laws which can be identically superposed on those of the special theory of relativity without divergence at any point: in other words their x axis must tilt with relative motion by an angle θ' defined by $\sin \theta' = i \tan \theta$, where $i \tan = v/c$.

On this conception, there is nothing to preclude a preferred Newtonian system of reference, with absolute space and absolute time; we only have a veto on any observer recognising, or even occupying, this preferred frame of reference.

There is no known fact of nature which contradicts this viewpoint in which we reconcile the conflicting views of Newton and Leibnitz, of Einstein and Lorentz-Fitzgerald. The law of compounding velocities is such that no observer can tell whether he is in motion relative to some fixed absolute frame or at rest within it, or whether such a frame exists, provided always that he cannot participate in it himself; on this latter point he can very soon satisfy himself by observational experiment. Just as we have the wave and the particle concept of matter building up to a concordant whole, we shall have the relative (Einstein) and absolute (Newtonian) concepts of space-time, with the proviso that the Newtonian concept must remain imaginary .

Note. Recently Dirac has suggested a new approach to the problem of the ether which arrives at conclusions similar to those we have here put forward. He begins by setting up a wave function which makes all values for the velocity of the ether equally probable, and this shows that this wave formation cannot be normalised ; this state therefore should be looked upon as a theoretical idealisation, which can never be actually realised, though one can approach infinitely close to it. This wave function then represents the perfect vacuum state in accordance with the principle of relativity, just as we too identify our Newtonian frame of reference with the perfect vacuum into which no actual particle can penetrate. We are then met with the further antinomy that the perfect vacuum corresponds to the laws of a material substratum, while the world of actual matter corresponds to the laws of a void substratum. As we shall show, the reason for this is that the ultimate particles of matter which form one world have been transferred from the substratum of matter to the substratum of the void, and that all measurements between any two of them must be governed by its laws. The perfect vacuum does not exist, it is our representation of the perfect plenum into which no particle can penetrate without losing its particulate identity.

We may perhaps here also mention another recent paper which fits in well with the general background of our thesis. In view of the very general derivation of relativistic invariance (in the

absence of an appreciable gravitational field) , we can well understand that Thomas (L. H. Thomas, Phys. Rev., 85, 868 (1952)) has shown that the dynamics of a system of particles interacting at a distance can be relativistically invariant if the assumption of invariant world lines is given up; the only provision which our thesis sets forth is that each and every particle should measure itself as the centre of a motionless frame of reference, and this in no way presupposes the necessity of relativistically invariant world lines.

It is our contention that the present school of relativistic physics has laid undue stress on the ideological solutions compatible with the substratum of a void, while neglecting the solution which would accord ideologically with a material substratum.

The Quantum Effect.

There are two further extensions of such a spatio-temporal theory.

Firstly we may seek to find the quantum effect in nature on a discontinuous process of expansion of our four-dimensional hyper- sphere. As long ago as 1913, Poincarre suggested that the existence of a quantum of action ineluctably involved the existence of a quantum of time. We should merely be returning to his original suggestion if we adopt this genesis of the quantum effect.

The Velocity of Expansion of the Universe.

Secondly, Dirac has suggested that the universal constants may be variable in time, and may have altered during the expansion of our universe. If time ran quicker (i.e. if the interval of time was shorter) at the inception of the universe, the velocity of light would be slower, measured in cm. sec.-l, and whatever the present radius of the universe, we might be able to accommodate it to a system in which the distance t in a fourth dimension always exactly equalled the distance in space covered by light in a similar interval of time.

When dealing with the speed of the recession of the spiral nebulae. we have also the constants *h* and R_∞ which must intervene in the measurement, since *v* depends upon $\alpha^2 cR_\infty$, α is itself $2\pi e^2 / hc$, and *h* in turn equals $\left[2\pi e^5 / c(e/m)R_\infty\right]^{\frac{1}{3}}$. If we write $R_\infty = 2\pi me^4 / ch^3$, we see that R_∞ will remain invariant however we vary *c* and *m*, if the only variation in *h* is attributable to the variation of these two factors. If *h* varies only with *c*, then ν will vary as $c^{1/3}$. Therefore ν would increase in the past, and λ decrease, if the only variation occurred in *c*. If m increased, since G might be expected, in the event of its being a variable, to increase in the intense gravitational field arising at the time of the inception of the universe, there could be an additional decrease in λ. Whatever the variation in *m*, part of the red shift of distant spiral nebulae would be masked; the nebulae would be receding faster than our direct calculations would show, the universe would be expanding more quickly than we had previously imagined.

There is another possibility which is perhaps the simplest of all. It has been shown that for the red shift to hold for receding nebulae there can have been no variation in α, the fine structure content, throughout time. Even if we keep *c* constant in the past by decreasing pari passu the direction of time (increasing the speed of the universal time cycle t_0, hence diminishing its duration) , we can limit the spatial extent of the universe at the present moment to any value compatible with observation, or calculation, while, postulating that the spatial expansion in the time dimension has always been proportional to c.

The Velocity of Light.

At all events if we adopt $c\sqrt{2}$ for the spatial distance covered by a photon in the *t* direction (at an angle of 45° to the absolute time axis along which the distance is *c*), we shall find that the group velocity of light as calculated relativistically becomes equal to the value it assumes when calculated classically. This would seem a highly significant fact, not lightly to be pushed into the background.

Determinism.

Returning to the four axial representations of space-time symmetry, (a), (b), (c) and (d), it is tentatively suggested that the successive reciprocal values which *i* assumes in (b) are a measure of the determinism which each quantum step propagates in the absence of a gravitational field. Should the future not be infinite, but involve n quantum steps, then it might be assumed that each quantum step was indeterminate to the amount i/n. The breach in the laws of causality would be infinitessimally (as opposed to infinitely) small during each quantum step, and indeed throughout measurable time, but the final state of the universe would be completely undetermined by that existing at its inception.

Further Elaboration of a Universe Expanding in Time and in SPace: Three- Dimensional Universe.

So far we have only examined an expanding four-dimensional hypersphere. We shall now attempt to restrict this idea by reducing our four-dimensional world to a three-dimensional world, expanding radially in every direction, and defining the time direction as the direction of radial expansion. Then we shall be reduced to considering time as a pure imaginary , and we should construct a mathematical picture indistinguishable from that of present day relativistic physics, although we have abolished an actually existing fourth dimension. We should however have to abandon an ether corresponding to the past or future, and our synthesis of relativistic and absolute concepts. We should also either have to admit a vast spatial void at the centre of our universe or abandon a constant radial expansion of all matter with a velocity of *c*, which alone can reconcile the group and the phase velocities of light. We should however, in spite of our restriction, obtain a further freedom which would assist us to interpret the fundamental laws of quantum mechanics, and which we shall find indispensable when establishing the basis of the self-exchange interaction: we should be able to displace the centre of the universe with respect to its location at its inception, because we could displace it in some direction of space, and regard this as an imaginary super-time.

Five-Dimensional Universe.

Rather than abandon the fundamental conceptions we have so far developed, we may adopt the five-dimensional world of Kaluga. We can then do two things: we can, as the universe expands, displace its centre along the fifth-dimensional axis, and we can make every fundamental particle rotate through the poles of the five-dimensional world we have thus created, if we assume that there is a pole in the future as well as the past. The pole of the past would of course correspond to the point of the inception of the universe; the pole of the future would be situated at a distance equidistant from the present. The rotation of the fundamental particles should be considered as virtual or imaginary except for materialisation at equatorial phase and antiphase. This conception would be further founded on the fact that our fifth dimension would be associated with *i* at all points except at phase and antiphase; this is obvious if we construct an axial diagram similar to that already drawn in which this fifth dimension or supertime replaces the fourth dimension of time, for such a diagram accords complete freedom of rotation round the origin of the diagram from pole to pole (represented by *i* and -*i*) through equatorial space (represented by 1 and -1).

We could do more still, for at every half revolution of matter we could invert past and future, so that one would be the mirror image of the other, the future of one would be the past of the other and vice versa. We would. indeed derive such an effect logically from our diagram if we made

our particle rotate counter-clockwise, for along the positive spatial axis the immediate future would remain the future, while along the negative spatial axis the immediate future would be the past. Then with respect to this fifth dimension time would invert and change sign at every half revolution of universal matter, and all matter would be materialised in two half worlds. But only one of these would be troubled by light and electromagnetic radiation, for all photons are true bosons; the other would lie for ever in stygian darkness. The world of photons and matter would be associated with positive time, the dark world with negative time. We should indeed have two worlds strangely reminiscent of purgatory and hell.

This conception would carry with it two far-reaching advantages which would complete the concepts we have already advanced.

(a) There would exist a still more fundamental prototype of the laws which force a symmetry on fermions, so that the four- dimensional asymmetry which we shall subsequently analyse in detail in the case of mesons and the basion would correspond to the most fundamental law of existence, that of materialisation. For as we shall see there is no such compelling reason to be adduced in the case of nucleons themselves, as opposed to their components parts, since here, as we shall show, the axis and the plane of spin have no component along any axis except the three axes of space. If however the law which connects fermions with asymmetry is the most fundamental of all the laws of nature, we can be prepared for it being carried over unchanged into the three dimensions of space.

(b) Eddington, among others, has pointed out that the formulation of the laws of the general theory of relativity require ten dimensions for their adequate expression; if we count our five dimensions twice, once for the symmetrical world, and once for the asymmetrical world, we should have the ten dimensions postulated.

The Atom of Time: Co-existence.

The five-dimensional world we have described above will have for corollary an atom of time, t_0, equivalent to one period of revolution or materialisation, divided into two half periods of "co-existence" equivalent to $\frac{1}{2}t_0$. We can use the conceptions of an atom of time, t_0, as a basis for the quantum laws which govern nature, while we can postulate that all successive states occurring in a period of "co-existence" do actually, as well as virtually, co-exist together, and that all their spatio-temporal reactions are suck as are conditioned by this co-existence. On this view it is the change of the super temporal sign between phase and antiphase, between the world of light and the world of darkness, which prevents the co- existence of successive states by destroying them in perpetual rotation.

It is open to doubt whether existence is possible without rotation, and we see that it is the rotation of the universe about imaginary poles which imposes upon it, in conjunction with temporal duration, the cancellation of the preceding existence of the particle or individual. Eternity must presuppose co-existence, time cancels it; and there can be no possibility of constructing a tempero-spatial world when time does not do so.

SECTION II. THE STRUCTURE OF THE NUCLEON.

The Electromagnetic Field: Spin.

Although it will be shown that a three-dimensional analysis has hitherto caused no fundamental restriction to our conception of particle spin as applied to nucleons and nuclei, an attempt will be made to show that this is not so in the case of the electron, still less so in the case of mesons and the basion. The. restriction of spin to a three-dimensional analysis has also limited our comprehension of the essential natures of spin and the electromagnetic field.

This is the first time we have mentioned the electromagnetic field, and perhaps it would be as well to begin with an enquiry into its nature. We know that a charge will set up an electric field, and that a moving charge will set up a magnetic field, and we know that these fields are propagated with velocity *c* equal to that of light. They must therefore partake of the nature of radiation, and if so they might be expected to partake of a quantum texture. So far there has been no general acceptance of the quantum nature of the electromagnetic field, and this can be understood from the following analogy. Once an electron has emitted a photon of light radiation, the electronic process must be revised, and the electron must absorb a fresh quantum of light before it can emit another photon. At first sight it would seem that there is an endless and repeated emission of the electromagnetic field which is at variance with our example of the electron and the photon. We shall however seek to show that this in fact is not so, and that we are dealing with a perpetually repeated quantum-like emission in which a definite quantum is absorbed, emitted, reabsorbed and re-emitted.

We shall construct a universe in which the only charged bodies are electrons (negatrons, positrons) and mesons (positively and negatively charged), nucleons and nuclei owing their charges to bound mesons which, in contradistinction to present day theory, are real rather than virtual.

Spin.

It is our contention that spin is measured by the number of half periods of revolution prior to emission of the electromagnetic field. Since there can be no rotating charged particle without its electro-magnetic field[1],we see that there can exist no charged particle not possessing "spin" unless (a) it consists of an equal number of oppositely charged constituent particles, (b) the effective spin is revised at anti-phase. The first class is composed of nuclei with even mass number (Z) such as helium and oxygen; the second class may well be typified by some, or even perhaps ail mesons. The first class are so simple that they require no further comment; the second class will be treated in detail in what follows.

Particularisation of Spin Planes and Axes: Electric Charge.

(a) Basion.

We consider a nucleon to consist of an electrically neutral particle we term the basion, and four bound π mesons. The basion is a fermion (indeed the most fundamental of all fermions) and as such is antisymmetric. Since it must therefore reverse its spin every $\frac{1}{2}t_0$, its plane of spin must be the (t, x) plane, when x is the direction of spatial motion of the particle.

Like the neutron, the basion is neutral, but since it participates in the emission of the electromagnetic field, like the neutron it cannot be considered to be "anelectric," but its neutrality must result from the mutual cancellation of opposite charges. We have suggested that the emission of the electromagnetic field as the particles cut one of the axes of space and time was caused by some inherent spatio-temporal anisotropy of the particle, and that this might perhaps be due to an elongation into the past and a flattening of the future. If we consider the axis generating the electromagnetic field to be the *x*-axis, and the axis generating the Coulomb field to be the time axis (either of the absolute frame of reference or of the particle), then we may associate the stable form of electricity (positive for nuclei and negative for electrons) with the postulate that the particle cuts the time axis the "rightway up" (i.e. flattened in the future, elongated in the past), and the opposite form of electricity with the inverse postulate.[2]

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[1] We might go further and say that since no particle can be motionless in the absolute frame of reference, every charged particle must have a magnetic as well as an electric field.

[2] It is obvious that a particle can emit electromagnetic radiation at half periods of revolution, and yet always emit either at spatio-temporal phase or antiphase; its speed of rotation would only need to be an even sub- multiple of t_0. This is in fact always the case.

This proposal will however leave us with the conundrum as to why there should be two stable forms of electricity, and why we should recognise them as of opposite polarity-a conundrum we shall soon settle satisfactorily.

Since the basion is neutral, we must consider that it always cuts the time axis the "rightway up." Since the period of spin of the basion turns out to be, as we shall see, an even multiple of t_0, if it does not change its shape during its revolution it will change electric sign at every half revolution, being positively charged during the past when its own t is positive, negatively charged at the intersection when its *t* is negative.[3] We see therefore that in the case of the basion we are simply dealing with "charge conjugation," the fundamental physical postulate that charge changes sign on time inversion. The basion will therefore radiate a mutually cancelling field every $½t_0$.

(b) Meson.

The free π meson is a boson (we shall see that bound π mesons are fermions). At first sight this might be thought to require that the

spin must not invert at antiphase. There is however another solution. We shall see that the period of rotation of a meson is precisely to. If it inverts its spin at antiphase, the two opposed half spins would cancel inside an atom of time, and we should be left with zero spin.

In the former case (i.e. non-inversion of spin), the π meson would be a (pseudo) vector, in the latter (i.e. spin inversion) a (pseudo) scalar .

Two fundamental papers on time inversion have recently been published by Schwinger and Watanabe. From the first, it would appear that for a particle not to invert its spin on time inversion would involve transgression of the fundamental laws of physics. If we maintain the viewpoint that there is no spin inversion at antiphase for mesons, we could point to two factors which might each be considered to playa role in the suppression of spin inversion :

(a) It may be a still more fundamental postulate that no spin inversion is possible in a duration less than 2 t_0 (or at least t_0 for fermions and 2 t_0 for bosons[4]). In this connection it should be noted that the basion reverses its spin every 2 t_0.

(b) We could make mesons rotate in the (t, y) plane instead of the (t, x) plane. Then since there is no motion in y, y must be considered as a point rather than as a line, as in the case of x. We can treat a line as a vector, and invert its direction, but we cannot invert a point, which must be treated as a scalar. If we make the meson rotate in the (t, y) plane, we shall therefore suppress spin inversion.

(c) If we consider that the meson does in fact reverse its spin at antiphase, we must allot to its rotation the (t, x) plane, as for the basion. We do not feel that the evidence available is perhaps yet sufficient to be decisive in a choice between the various hypotheses. We shall however proceed on the assumption, which seems so far heuristically the most fruitful, that there is no actual spin inversion at phase and antiphase, but that the sign inversion of antiphase leads algebraically to formal spin inversion. This is equivalent to the previous suggestion in our footnote that such particles present the "wrong" spin at antiphase: viewed from the supertemporal (fifth dimensional) antipole, the particle must be spinning in the opposite direction.

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[3] It is obvious that asymmetry will cut the time axis when the t vector changes sign and in zero. We shall therefore have to allot the Coulomb field generated either to the half cycle immediately preceding or to the half cycle immediately succeeding the intersection. For the moment there appear to be no grounds on which to make a choice.
In the case of the emission of the electromagnetic field, there can however be no ambiguity of choice, since at any intersection of the x-axis the t vector is either positive or negative.

[4] If no spin inversion in a direction of to were possible, all particles would possess the "wrong" spin at antiphase. This might be held to .ïnvert" the world in a still deeper sense.

As far as bound mesons are concerned, whether fermions or basions, since there are always four per nucleon and the sum of these spins identically zero, at every phase and antiphase derogations from the law of spin inversion (if we were to consider absence of "actual" spin inversion a derogation) would cancel out identically for the two pairs.

We shall indeed see in our subsequent detailed analysis of the spins of the various types of mesons (free, bound and virtual) , that the true solutions are probably more complicated than the pre- liminary analyses which we have given here. This latter however serves as a preliminary introduction to establish our general line of argument.

(c) Electron.

We are going to propose that the electron in the s state rotates, like the basion and perhaps the meson, in the (t, x) plane. We can then understand that although the s state is isotropic the orbit has zero orbital momentum in space ($l = 0$). We can then say that Bohr's k ($= l +$ I) represents the four rather than the three dimensional view. As l increases for a bound electron, we consider that t (particle) tilts away from t (absolute). till when $l = \infty$ and the electron is free, we find the plane of spin. still about the z axis, to be the (y, x) plane. We further consider that the free electron has two possible orientations of the plane of spin about the z-axis, the (y, x) plane and the (t, x) plane, and that it is the passage from one state to the other which furnishes the quantum jump necessary for the free electron to emit magnetic radiation as the asymmetry cuts the x-axis. The bound electron can always emit as the asymmetry cuts the x-axis in the plane of spin, and the quantum can be furnished by the orbital momentum.

The whole problem will be treated in greater detail in Appendix II, (ed Apparently never drafted.) where the case of the bound electron will particularly be investigated. We shall have to deal with the free electron later in this present paper, for it is obvious that the emission of the Coulomb field will raise difficulties if spin were restricted to (y, x) plane, and, as we shall see, the problem of the spin of the free electron turns out to be the starting point in the calculation of the masses of the π meson and the proton.

Stability of the Electric Charge.

We have seen that there is here an apparent difficulty or impression which requires clarification.

To obtain this we must return to the inception of the universe. It is postulated that a four-dimensional hypersphere of ether appeared in space, and that it expanded, leaving a hollow hyper- spherical void on its interior. With the voyage along a fifth or supertemporal direction of the centre of the void we are not here concerned. Thus was accomplished the creation of the universe, but of an empty universe. Next, at a very early stage of evolution, a vast polyneutron of ether erupted into the void. As the hollow hypershere expanded, we could conceive of the pressure exerted on the internal face as stabilising the expansion, and the hyper- volume of the ether could remain constant. Not so however the polyneutron, which would have to increase its volume, and would therefore be subject to explosively disruptive forces. The explosion of the polyneutron filled the empty universe with matter and radiation, in the form of neutrons, each with its basion and four attendant bound π mesons[5]. These in turn mostly decayed into protons and electrons, and our world of radiant energy was born.

It is our postulate that the basions and mesons clung to the spatial interface of our expanding hollow hypersphere, while the electrons and waves of light were created on the ether surface itself. However closely nuclei appear to be integrated with electrons and light, it is therefore our contention that they exist on opposite temporal sides of our spatial interface, basions and bound π mesons in the past, electrons and light in the future. We can then at once understand why what is the stable sign of electric charge for the one should be the unstable charge for the other, if we

[5] Perhaps there was an intermediate stage involving a dineutron without meson, which broke up into two neutrons and eight mesons

assume that what we recognise as positive and negative electricity is precisely the specific nature of the anisotropy presented to us in our inter-facial world, at the moment of the generation of the Coulomb field.

For it is obvious that what appears to us as positive electricity in nuclei (viewed towards the past) will appear to us as negative electricity in electrons (viewed towards the future).

This view would satisfactorily differentiate between positive and negative electricity and explain charge conjugation in its broadest sense (apart from rotations involving a plane containing the time axis-as in the basion and mesons), which we could interpret as a statement that the reactions of past and future on the spatial interface must always balance each other .

A word about mesons, which are in a particular position. We consider the four bound π mesons accompanying every nucleon as belonging to the world of basions, nucleons and nuclei. On the other hand, we shall show that free mesons belong to the "present." They are the only denizens of the "present" -hence their intrinsic instability. We shall show that these are never emitted from the nucleon complex which pre-existed their emission; in all cases they are created afresh by the energy available for their materialisation. We see them as we might indeed expect, that when new particles are created which are not electrically neutral, it is not their spatio- temporal asymmetry which is of paramount importance, but the reaction of their spatio-temporal asymmetry on our spatial interface.

Finally it is not impossible that when we combine two protons and two neutrons to form an α-particle, one set of bound π mesons may serve for two particles, with the result that we should in reality have four particles each with a charge of $\frac{1}{2}e^{+}$ .If this is so, we might expect each basion to absorb two bound π mesons, and the binding energy of the α-particle might be considered largely as a measure of the energy liberated by this coalescence. Disruption of the α particle (by nuclear disintegration) would reform the original bound π mesons.

Further Considerations Concerning the Electro-magnetic Fields.

With the exception of mesons, about which at the moment we know all too little and a certain number of nuclei of even Z, all charged bodies possess spin.

When we made our original analysis of the connection of light and a particle rotating, either in the universal frame of reference or in its own frame of reference, with a peripheral equatorial velocity .equal to $\pi c/2$, it was shown how the (t, x) axis of light must be tilted at right angles to the (t, x) axis of any particle, and therefore of the emitting particle also. If we were to make the particle move with respect to the universal frame of reference, it too would tilt its (t, x) axis with respect to this frame of reference. By the equations .of the special theory of relativity, which we know to be heuristically valid, and which we have ourselves derived[6], we know that as we tilt the (t, x) axis of a material particle, the (y, z) axis remains immutably fixed. We may if we like attribute the increase of mass with increasing velocity to the strain of rotating two axes of space only while we keep the other two axes fixed. Indeed when we have completed our rotation through 11/2, mass has become infinite. We shall therefore make the assumption that when we emit photons, all four axes are free to rotate, and it is this axial freedom which deprives a photon of a rest-mass. We can then associate the electromagnetic field with emitted radiation, and understand why its effects should be to exert force at right angles to the direction of motion of the electric field. And since there are two isotropically orthogonal axes of space (y , z) at our disposal for these orthogonal transformations, we can only satisfy this isotropic relation by making the magnetic field rotate around the x-axis if this is fixed and linear[7]; while conversely

[6] We do not mean by this that the previous derivations of the special theory of relativity were heuristic only; the validity of these previous derivations is one of the cornerstones of science! They are however not entirely closed to criticism (see especially Majoriana).

[7] The electric and magnetic vectors will both rotate, unless polarised. Similarly in an unpolarised beam of light, the waves are spread out uniformly over all possible angles from 0 to 2π.

if the electric current rotates, the magnetic field will become linear, since there is now only one orthogonally invariant axis at our disposal.

We see then why the electric magnetic field must be emitted as the spatio-temporal asymmetry cuts the x-axis Similarly, we may consider the static electric (Coulomb) field to be emitted when the spatio-temporal asymmetry cuts the time axis (as indeed must result from our previous supposition that the electric charge is defined by the shape of the spatio-temporal asymmetry at the moment of cutting the time axis), for with respect to our three spatial dimensions the time axis (and in particular the universal time axis) must be considered static and isotropic.

We must always remember however that electromagnetic emission is the result of the asymmetry in rotation of the basion, mesons and electrons, and that the final emission of the electromagnetic field by the nucleon as a whole is subject to a more complex law derived from the self-exchange interaction. We shall in fact show that the nucleon itself has no component in the plane of rotation along the time axis, and that the magnetic field is radiated in a single quantum jump when a quantum of electro-magnetic radiation has built itself up as a result of the self-exchange interaction, and that this radiation occurs once during every half rotation of the nucleon as a whole.

The Spin of the Free Electron.

We shall begin by assuming that only the past and the present are subjected to universal time reversal. This appears reasonable, inasmuch as this inversion is conceived as an inversion of the past about the present; the inversion is therefore cut off by the present, which isolates the future. This must have its repercussion in the spin of the electron (here we shall only deal with the free electron) and will result in the time component of the plane of spin during the negative half cycle of universal time reversal being rejected from time into space. We shall thus get two half cycles of spin, of which that during the positive half cycle is like that of the basion (and perhaps the meson) , in the (t, x) plane, while the second half cycle will be in any spatial plane, since the particle must be thought of as "decoupled" from its positive existence.

The first consequence of this state of affairs is that the electron must be a fermion.

The second consequence is that the electron will possess fixed electric polarity, and will not become a neutral particle like the basion. To account for unit charge, we must equate charge to number of time axes cut per number of time axes available in the period to. It should be noted that under no circumstances would the electron change sign, since its period of revolution is to.

The third consequence is that we have two states from which we can make a quantum jump for the emission of electromagnetic radiation. There will also be a fourth consequence. If we resolve our previously expressed uncertainty as to the generation of the Coulomb field when the spatio-temporal asymmetry cuts the time axis by postulating that the field defines the past which has generated it and is emitted into the future which receives it (these indeed are the laws governing all radiation), we shall have a negative Coulomb field if the half cycle in positive universal time is so executed that it -commences where the (ed ?) L vector is positive and ends where the vector is negative. Then if we apply the same reasoning to the emission of the electromagnetic field, this must take place at the inception of the half-cycle just defined, and describe a state where every plane in space is equally probable, since this was the case in the preceding half-cycle. When we orientate electron spin in a magnetic field, we must consider this orientation to take place in the negative half cycle of universal time, and orientation must be imposed by the field received as it enters this negative half-period. Spin will therefore be measured as completely isotropic and will no longer be bound up with the x-axis (otherwise we should have had to exclude the x-axis from the plane of polarisation of the spin in a magnetic field) .

We shall see that in the case of the nucleon we obtain a similar isotropic freedom, since the spin of the nucleon system as a whole obeys the same prescription; the t axis is excluded, and all three axes of space are equally probable. We shall also subsequently see that these prescriptions are bound up with the s state.

The above conception will bring us directly to the suggested "Doppelwirbel Bewegung" of the free electron proposed by A. Meissner, provided we allow the electron to execute alternative half periods of purely spatial spin in opposite senses.

Spatio-Temporal Configuration of the Present.

As previously proposed in this paper, we consider the present to constitute a three-dimensional film of hypersurface, dividing the past from the future. We have also proposed, and shall subsequently prove by exact calculation, that this film is not strictly speaking non-dimensional in the time dimension (otherwise the present would be "virtual" and the existence of the universe an idealisation or a dream), but possesses organisation. We shall proceed to envisage a more restricted hypersurface which is strictly non-dimensional in time, and we shall place light and electrons on one side of this present in the future, while we shall place basions and bound 77 mesons in the past. Only the free mesons will be allowed to enter the present, and since time is non-dimensional, these must be bisected by the present.

We must however make it quite clear that this picture represents a dimensional rather than a temporal arrangement: the particles specified are so arranged in four-dimensional spaces, but from a temporal point of view their organisation is simultaneous. Time is only indirectly measured by our passage through the unperceivable fourth dimension; it is measured rather by the revolution of phase and antiphase, particle and antiparticle, in the fifth dimension of hypertime. We are faced in fact with the passage along a fourth dimension we cannot perceive of a band so organised that all its actions and reactions which we register as simultaneous are in fact simultaneous provided the organised particle is associated with an integrated world line (in the sense of general relativity). This can the more readily be understood since no part of our three-dimensional space is involved in this simultaneity: action and reaction are transmitted instantaneously because the distance is rigorously zero.

Finally we may ask what the three-dimensional surface non- dimensional in the fourth or time dimension represents. From what follows, it will become apparent that it must represent the limit of universal, and therefore of our own, percipience.

The Masses of the Free π Mesons, the Proton and the Neutron.

We are now about to perform a calculation never hitherto attempted or envisaged. We know that the electron represents a unit charge in the future. We are going to transfer this unit charge, first into the present, and then into the past, and check its variation in mass, using the postulates we have so far elaborated, and adding to these one further postulate to the effect that the work we have to perform is stored in the particle and represents itself in our world of the present as mass.

We shall first examine the general problem. Our electron has half its spin in the (t, x) plane, its other half spin purely in space. Viewed from the (x, t) plane of the present this purely spatial half spin will appear linear, if one of the two spatial axes were the x-axis. We should then have to multiply the linear measurement by πr , when $r = \frac{1}{2}d$, the diameter of the half spin in space. But the half spin in space can exist as such although the x-axis is totally excluded. We must therefore to solve our problem measure the conversion when we remove the half spin from the (y, z) plane to the (t, x) plane. If we measured a whole spin with conversion from the

(x y/3) plane to the (x, t) plane, we should get $2\pi r$. Our half spinfrom the (y, z) plane to the (x, t) plane will give $(\pi r)^2$, multiplying by πr for each dimension we have introduced. We may rewrite this as $(2\pi s)^2$, when s = i.

(a) The Free 1T Mesons.

Having got so far we find that we cannot transfer a unit charge into the present, if we restrict ourselves to a single particle, even if we let our present bisect the particle. But the line is imaginary (strictly non-dimensional) and the particle actual. The operation is therefore per se

impossible; and however close to the imaginary line we bring our actual particle, it will still be in the future or the past.

To achieve our object we shall have to double the particle and make it a compound particle consisting of two halves. Then if we charge each half oppositely[8], and bring them sufficiently close to the present, we shall get, if we let them rotate in phase, two half charges of the same sign at the phases further removed from the present[9], while we can bring the other two alternately occurring phases so close to the present that each loses its charge (since the charge changes sign on each side of the present, the charge must disappear and reappear as it crosses the boundary).

Similarly we can obtain a particle of unit charge if we take two similarly charged particles and let them rotate out of phase.

Next we may tie up phase not only with electric charge, but with spin : we may distinguish the two spins with respect to time not only in that they are in opposite physical senses, but in that they cut the time axis at alternate periods of $\frac{1}{2}t_0$. Thus one will cut the positive time axis, the other the negative time axis, as it approaches the (positive) future. We shall then have electric phase and spin securely bound to each other, and we shall also be able to account in later calculations for the fact that each spin within an interval of $\frac{1}{2}t_0$ seems to have a definite sign attached to it: positive or negative.

As we shall show the free meson derives from an electron and a positron. But we cannot bind these two oppositely charged particles (unless we should make a particle in all senses with the basion) without first (a) giving each a neutrino (for the electron cannot disintegrate without its accompanying neutrino) ; and (b) dividing the electron and positron into two halves, so that immediate dis- integration may be obviated by separating the halves. Our postulate is that both electron and positron are halved-and since each half must have the same spin, we are faced with a triplet state. We do not associate a neutrino with a chargeless electron, but connecting charge and spin, take a chargeless, spinless electron and divide it into two halves, to each of which opposite spin is imparted. Returning to the $(2\pi s)^2$ which we have already derived as our factor of multiplication, we must therefore first substitute our new value of s (for our composite body derived from four half spins must be a boson), and then multiply by 7(= 6/2 + 6/2 + ½ + ½). The spin of the composite particle must be zero, since each half consists of an electron (positron) spinning in parallel, while the neutrinos (as will be shown) will cancel the unit spin resulting from the electron (positron) group. This is the situation as observed and measured outside of to. But as measured inside to, the spin of the electron (positron) group will reverse every t to (since they are charged particles-the same could be true even if they are particles neutralised by cancellation of charge) ; while the neutrinos, since they are ipso facto neutral particles, and entirely unchanged, will reverse their spin $+\frac{1}{2}t_0$, in spite of the fact that they are fermions.

Note. A unitary boson, like the photon, will not reverse spin inside a half period of $-\frac{1}{2}t_0$, although it has an electromagnetic vector. As a corollary , a fermion will reverse spin inside a half period of $-\frac{1}{2}t_0$ when it has an electromagnetic vector (even if this cancels), but will reverse spin if it has no electromagnetic vector at $+\frac{1}{2}t_0$. We say "as a corollary" because the three cases must be distinguishable, and granted the solution for the photon, the other two cases follow *ipso facto*. As viewed inside a unit period to, the π meson will have spin 2. The resultant net spin is 1, and this is the spin which we must adopt in our calculations, since, as we shall see in the case of the proton also, we must allow for states both inside and outside of t_0. It may be noted that were the spin of the free π meson zero inside the unit period to as it is outside, the π meson would necessarily dematerialise.

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[8] When we speak of opposite charges in this sense, we mean of course that each particle is intrinisically oppositely charged, that is they will have the same charge when viewed along the same time axis if one is in the future and the other in the past.

[9] We must remember, that unlike the basion, the meson rotates in a period to, and our two time axes will therefore have opposite signs

We see then that we must put s = 1, and the total mass of our free charged π meson will be 7 $(2\pi)^2$ = 276.35 electron masses, which is almost certainly within one unit of the true value.

Turning to the π^0 meson, we must put our oppositely charged particles out of phase : if we change the sign of the time axis every $\frac{1}{2}t_0$, this must be equivalent to changing the electric field, and our composite particle will now be neutral.

We must not however forget our neutrinos. We may assume that the composite particle will no longer be stable if an electron and its neutrino get in phase. If we have our electron and positron fragments in phase, we can also have both neutrinos in phase with each other and out of phase with the electron positron complex, which we have seen to be the case in the charged $\pi^{\pm}$ meson. But if we have our electron positron fragments out of phase, then whichever phases we allot to our neutrinos, one will always be in phase with one of the electron positron systems. To stabilise the particle we must eject half a neutrino, thus dephasing the other half neutrino while allotting different phases to the other two half neutrinos; the mass of the π^0 meson will then be π^2 electron masses lighter than that of the charged π meson, or in other words a value of 9.87 m. against a measured value of $(10 \pm 2)\ m_e$. It may be simpler to insist that if the electron positron complex is in or out of phase, the two neutrinos follow suit and are in or out of phase. The remedy of expelling half a neutrino will always prove effective.

Finally, we see from the phases (spins) allotted above to the charged and uncharged π mesons, that both must be (pseudo) scalars and not (pseudo) vectors, since they must have zero spin.

There will be a further corollary. As we have associated phase with spin, we see that an electron and a neutrino can only enter into a disintegration interaction if they possess parallel spin. In the case of a disintegrating nucleus, this must have anti-parallel spin to the electron-neutrino complex. Should it be desired to keep not only the quantity of angular momentum constant, but also its sign in a nuclear disintegration; we can always allow the disintegration to involve spin-flip of one of the three fermions involved. Should this spin-flip be allotted to the neutrino, we should have two observable particles with opposite spin which have conserved sign as well as quantity of angular momentum. The cause of the disintegration of the $\pi^{\pm}$ and $\mu^{\pm}$ mesons will be dealt with later.

(b) Proton and Neutron.

So long as we restricted the transfer of our unit charge into the present, we had only the (t, x) plane to consider. If we transfer it into the past, we must reintegrate the (y, z) planes, since we have here a void space of four dimensions in which motion is possible. Besides spinning in the (t, x) plane, the particle must therefore also be able to spin in the (y , z) plane. And since no particle can spin in more than one plane at the same time, we accommodate this prescription by making a different type of compound particle, and allowing the constituent parts to spin in the (t, x) plane and the particle as a whole to spin in the (y, z) plane[10].

Next, as we shall show later, and as we have assumed in our previous calculation, quantum laws do not apply inside t_0 and for our (t, x) plane we must write $(2\pi s)^2$ with $s = \frac{1}{2}$. But the spin of the nucleon as a whole takes place in an integral multiple of t_0, and we must, as will also be shown, apply quantum laws to this spin. We therefore now get a further factor of $(2\pi s')^2$ where $s' = \sqrt{s(s+1)}$.

We have still the tilting of the space and time axis with velocity for which we must allow, which will give us a further factor of $2\pi s$, when, if we allow for approach and recession to and from opposite directions of x space, we see that s = 1. Of course, as in the case of the electron, the x axis is also open to the plane of spin, which becomes spatially isotropic. We therefore obtain a

[10] If we restrict the spin to ½, and use only a half cycle, we shall obviously have to replace approach and recession to and from the x co-ordinate in either direction with approach or recession for the appropriate spin ; two oppositely opposed spins are therefore substituted for s = 1, which is as we might anticipate.

complete factor equivalent to $(2\pi s_a)^2$ x $(2\pi s_b)^2$ x $2\pi s_c$ when $s_a = ½$, $s_b = \sqrt{s_a(s_a + 1)}$ with $s_a = ½$ and $s_c = s_a + s_a$ with $s_a = ½$. This factor works out to $6\pi^5$ or 1836.10, which to within ±0.04 units is the measured mass of the proton compared to that of the electron.

We shall subsequently show that the difference in mass of the neutron compared to that of the proton corresponds precisely to the increase in mass needed to cancel the unit positive charge carried by the proton.

One further point of great interest emerges from these calculations. Taking the factor in the case of the π meson as $4\pi^2$, we find we have two particles (electron complex and positron complex) and four states, since each particle has two states corresponding to the positive and negative half cycle of universal time (inasmuch as the two particles are on opposite sides of the present, the two sets of states cannot degenerate into a single set). The proton (and neutron) have 5 particles (basion plus four bound π mesons) and 6 states, three in each of the half cycles of universal time. This too we shall show later. We see then that the index attaching to π gives the number of sub-particles. It is noteworthy too that one of the other factors in 2π (i.e. when s = 1) is quite a different nature to the other four; equally the basion is of a quite different nature to the four bound π mesions. Only one of the factors of 2π deals with change of spm (when s = 1); and here again It will be shown that only the basion determines the total spin of the neutron by its change of spin.

The bound π meson lies wholly in the past, and we shall not deal with it here, but in a more appropriate place.

The General Organisation of the Universe: Mind.

If the picture so far constructed is analysed so as to inspect its fullest consequences, we must enquire further into the nature of the fourth dimensional "void" through which (or at the spear point of which) we are invisibly advancing with velocity *c*. We have already seen that what we define electrodynamically as the vacuum state, turns out to be, not a vacuum, but a plenum. Similarly a logical reconstruction of the world of percipience from the bricks we have so far fashioned must indicate that the so-called fourth- dimensional vacuum will not turn out to be a vacuum as we know it, but mind, percipience itself. All matter will then be moving in a sea of mind. Closer inspection will show us the fundamental logic of this conception: in the plenum, of whose fragments isolated in mind our universe is constructed, we have the absolute mathematics of an absolute Newtonian frame; while in the miscalled void which is mind, all frames of reference and all systems of mathematics are relative, as we should anticipate when we reflect that all sensations and all mental judgements are qualitative rather than quantitative.

Truly may it be said that "Nature abhors a vacuum." We must conceive of the "now" of the present, the "now" of observation, the three-dimensional film with no fourth or time dimension, as the limit of this ever expanding ocean of percipience. We must conceive of the electrons as building up a wall of "field," shielding the plenum of the ever expanding ether, through which "mind" cannot penetrate. It was, we believe, Bertrand Russell who one suggested that percipience lay in the electron. Our thesis is the diametral opposite.