6. Space–time Analysis

Space–time Motion

From the foregoing account of various physical phenomena it has become quite clear that we cannot evade the need to analyse the details of space–time structure. The existence of the aether is not a matter for speculation. It is subject to straightforward analysis in simple and logical terms. What has been presented already serves merely to show that we need not be deterred by the presence of Einstein's Relativity, by Quantum Theory or Wave Mechanics. The aether, or space–time, as it has been termed, can make these various theories, or at least the experimental evidence supporting them, fit together in one unified structure. Now, guided by the contents of the previous chapters, it is necessary to attack the problem of analysing this aether. It would, of course, have been more logical to start with this analysis, but the author would have perhaps been taxing the reader's patience to embark upon such a task without first showing where accepted theory is weak and demonstrating some of the potential of a new approach.

To proceed, space–time has been shown to comprise a uniform continuum of electric charge permeated by a cubic array of electric particles of opposite polarity. Any normal motion of these constituents of the aether has, at all times, to be parallel or antiparallel. This means that motion is harmonious, probably in circular orbits. The requirement for the mutually parallel or antiparallel motion state comes from the law of electrodynamics presented in Chapter 2. With such motion the forces between charges act directly along the line of separation. There are no torques in the space–time system. Action and reaction must be balanced. Hence this basic motion condition. With it comes the condition of universal time, the *Hypothesis of Universal Time* introduced in Chapter 4. This is consistent with the property of the electrical system by which the positive charge is attracted to the negative charge by a force proportional to displacement. This is the feature of the linear oscillator, the cause of the fixed period oscillation of the universal time. It is this condition that force is proportional to displacement which tells us that we are not dealing with particles of charge in both of the polarity systems. Instead, we note that if a particle of charge is located in a uniform continuum of opposite charge, and is displaced from a neutral position, it is subject to a restoring force proportional to displacement. If a lattice array of such charge contained in particle form is displaced as a whole from the neutral position, then each particle in the array will, in effect, be subject to its own interaction force with the continuum. There are constraints operative to hold the array cubic in form, as already explained, but essentially the lattice remains as a kind of whole unit capable of motion as a whole. It may be subject to local disturbance in the presence of matter and under the effects of electric fields due to matter, but we are speaking of an entity, which has properly been termed a *frame*, the *E* frame, in previous analysis. This means that the lattice particle constituent in space–time is formed like the atoms in a crystal and can withstand *linear* force, whereas there is less restraint on the development of spin or rotation within the lattice. Note that this is a most important feature. The need to balance linear force in the application of Newton's Third Law of Motion has misled physicists who cannot admit the aether. Without it, there is no complete system, as required by Newton. With it, there is a complete system and Newton's law holds. The true law of electrodynamics is then derivable from experimental results, and the Trouton–Noble experiment can be utilized to verify the reasoning. The aether, or, more properly, the lattice of space–time cannot withstand turning forces. The fact that it can turn has been the basis of the general account of the photon phenomenon. This is to be developed further below to derive Planck's constant. However, in connection with photon radiation, it is observed that momentum is propagated in quantum form. The lattice of space–time provides the rigid structure able to carry this momentum. On the other hand, energy is not transported by the photon. Nor is it transported by electromagnetic waves. Space–time is primed with energy. It takes and gives energy in quanta as it accepts and releases momentum quanta. Otherwise energy merely diffuses to be uniformly distributed, as in a gas communicating thermal energy by diffusion. In such a gas, energy released as heat can promote the transmission of a sound wave well in advance of the thermal migration of energy.

Returning to the electrical features of space–time, we note that motion is essential to its character. There is a definite displacement distance between the positive charge and the negative charge. The restoring force proportional to this displacement is in balance with the centrifugal force of the motion. The ground state, or basic motion state, is taken to be that in which the interaction energy between the opposite charges is *zero*. The electrostatic interaction energy would be negative for minimum energy conditions. This is ruled out because for minimum energy conditions there is no displacement of charge needing balance by centrifugal force action. Any motion is then random. There would be no basis for saying that time or anything else had association with universal physical constants. The zero energy condition is the most logical state, in the circumstances, at least if we consider only the two space–time constituents so far discussed in this chapter. Later, we will see that Nature is just a little more complicated than this.

Next, it is necessary to formulate the motion state of the space–time charge. Accordingly, let m_0 denote the mass of each lattice particle of charge e. Let ρ denote the mass density of the substance providing the balance and moving with the continuum charge, the latter being uniform and having a density denoted ρ. This is charge density, and it is opposite in polarity compared with the lattice particle charge. Let $x-r$ denote the radius of the orbit of σ, that is, the orbit of the G frame, whereas the particles form the E frame. Also, let Ω denote the angular velocity of their motions, as before. Then, since the restoring force on charge e is $4\pi\sigma e$ times displacement distance, balance of centrifugal force for both systems gives:

$$4\pi\sigma ex = m_0\Omega^2 r \tag{6.1}$$

$$N4\pi\sigma ex = \rho\Omega^2(x-r) \tag{6.2}$$

where x is the total displacement, the sum of the radii of the orbital motions of the two charge systems. N is the number of lattice particles in unit volume.

Before proceeding with this analysis, it is appropriate to note that previously, particularly in Chapter 5, it was assumed that the orbital radii of the E and G frames were identical. This remains to be proved. In the meantime, consider the following. Take two systems in dynamic balance at angular velocity Ω. Let their mass densities be ρ and ρ', and their orbital velocities v and v'. Then, balance of centrifugal force gives:

$$\rho\Omega v = \rho'\Omega v' \tag{6.3}$$

Angular momentum is:

$$\rho v^2/\Omega + \rho' v'^2/\Omega \tag{6.4}$$

Kinetic energy is:

$$\tfrac{1}{2}\rho v^2 + \tfrac{1}{2}\rho' v'^2 \tag{6.5}$$

Differentiating (6.5), a change in kinetic energy is given by:

$$\rho v dv + \rho' v' dv' \tag{6.6}$$

From (6.3) and (6.6), the change in kinetic energy is:

$$\rho v(dv + dv') = \tfrac{1}{2}\rho c\delta c \tag{6.7}$$

approximately, if the systems move at velocities approximately equal and if the relative velocity between the two systems, $v + v'$, is c exactly.

By comparing (6.7) with (5.3), it is seen that the results obtained in Chapter 5 do not depend upon maintained equality of the orbital radii of the two systems in balance. Only one system need be disturbed. Also, taking angular momentum given by (6.4) as conserved, comparison with (6.5) indicates conservation of kinetic energy. However, as previously explained, we need take only one of the two energy factors. If we assume invariable mass, we can take kinetic energy change and ignore the energy stored in opposing the restoring forces, as well as ignoring conservation of angular momentum. If we allow variable mass but constant kinetic energy and constant angular momentum, we are left with the same result by considering only the restoring force energy action. This is $\rho\Omega v$ times the distance increment $\delta c/\Omega$. It is the same as (6.7), and again does not impose any condition that both system radii should change together.

The whole point of this analysis is to show that the findings in Chapter 5 can be retained even though we specify that only the lattice particle system is disturbed by energy storage due to field action and matter. It allows the assumption that the charge density σ remains always uniform. Any distortion of the motion state of σ resulting in a change of radius of motion in one region compared with that in another would require a variable σ. This is precluded in the whole of this analysis. It is a firm assumption that the radius of the orbit of the continuum charge is fixed. It is assumed that velocity in this orbit is $c/2$. This is a matter for later proof.

Electromagnetic Wave Propagation

The particle lattice is the E frame of space–time. It is the electromagnetic reference frame. It is now necessary to show how disturbances are propagated at finite speed relative to this frame.

To proceed, the fundamental harmonious motion of space–time in its undisturbed state is ignored. Any forces needed to sustain such motion in the inertial frame are deemed to be present, but they are ignored because the analysis will consider only effects relative to the E frame. Then, we may follow the usual line of argument in electromagnetic theory. First, the force on an electric charge e is the product of e and what is termed the electric *displacement* of other charges present. Denoting this displacement D, the force on the element is:

$$F = 4\pi e D \tag{6.8}$$

The quantity 4π is introduced to keep the units right. Secondly, from the inverse square law of force between electric charge, Coulomb's law, the charge density σ of a system of charge giving rise to D may be evaluated from the relationship:

$$\text{div } D = \sigma \tag{6.9}$$

This expression div D is the divergence of the vector quantity D, since it represents the rate at which D changes with distance. Thus, if the charge e is initially at rest in a neutral position and is unrestrained against the action of the charge forming σ, a displacement of e through a distance x will cause D to become σx, from (6.9). The restoring force acting on e will then be, from (6.8):

$$F = 4\pi e \sigma x \tag{6.10}$$

This explains the basis of (6.1).

If a quantity H is defined by an equation of the form:

$$\int H ds = 4\pi \int C dS \tag{6.11}$$

where the integral of H is taken around the boundary s of the surface area S over which the integral of the quantity C is taken, and C denotes the electric charge conveyed through unit area of S and normal to it in unit time, an observation by Faraday may be formulated thus:

H

$$\int D ds = -\frac{1}{4\pi c^2}\frac{d}{dt}\int H dS \qquad (6.12)$$

Here, D is the component of electric displacement parallel to ds. The quantity c is a constant having the dimensions of velocity. It is the ratio of electromagnetic and electrostatic units, since H is magnetic field. In the above equation t denotes time.

Equations (6.11) and (6.12) may be written in the forms:

$$4\pi C = \text{curl } H \qquad (6.13)$$

$$-\frac{1}{4\pi c^2}\frac{dH}{dt} = \text{curl } D \qquad (6.14)$$

These equations represent Faraday's laws of induction. The motion of electric charge is shown, by these equations, to induce electric displacement elsewhere. The quantity H establishes the coupling in this process. It arises from the action of electric charge in motion. What H is, physically, is not explained by this conventional treatment. In the early chapters it has been suggested that the magnetic field H is a condition in which energy priming space–time, probably, as we have just seen, in a form of stored energy linked with the restoring action between the E and G frames, is deployed into a dynamic electric field energy associated with moving charge.

Now, the process of producing a magnetic field does not imply the radiation of electromagnetic waves. Faraday's analysis applies to the reversible energy exchange conditions we associate with magnetic phenomena in dynamo-electric machines and transformers. Historically, equations (6.13) and (6.14) were found to be inadequate if applied to current flow in an open circuit. Thus, a circuit which includes a capacitor undergoing discharge has current flow in which the charge does not traverse the open part of the circuit between the capacitor plates. To overcome this problem, Maxwell recognized that there could be a motion of charge *in the aether*. Such charge could give rise to a *displacement current*. Then, the expression C is replaced by $C + dD/dt$ to produce the equations:

$$4\pi\left(C + \frac{dD}{dt}\right) = \text{curl } H \qquad (6.15)$$

$$-dH/dt = 4\pi c^2 \text{ curl } D \qquad (6.16)$$

The term dD/dt introduces the electrical character of the aether and allows these equations to be used to account for the observed electromagnetic wave propagation phenomena of the aether medium.

In the absence of the effect C, that is, well away from an electric source, the equations can be put in the form:

$$dV/dt = c \text{ curl } H \tag{6.17}$$

$$-dH/dt = c \text{ curl } V \tag{6.18}$$

provided we put V as $4\pi D$, and put H as a quantity in electromagnetic units rather than electrostatic units, by dividing by c. The quantity V is electric field intensity.

In a plane wave propagation, both V and H are constant in magnitude and direction in a plane normal to the direction of propagation. Taking co-ordinates x, y, z at right angles and assuming propagation in the x direction, equations (6.17) and (6.18) give:

$$dV_y/dt = -(dH_z/dx)c \tag{6.19}$$

$$-dH_z/dt = (dV_y/dx)c \tag{6.20}$$

There is also a pair of similar equations relating V_z and H_y, the electric field intensity in the z direction and the magnetic field intensity in the y direction, respectively. Derivatives of the fields in the y and z directions are zero in view of the constancy applicable to the plane wave.

The combination of (6.19) and (6.20) to eliminate H_z, for example, produces:

$$d^2V_y/dt^2 = (d^2V_y/dx^2)c^2 \tag{6.21}$$

The general solution of this may be written as:

$$V_y = f_1(x-ct) + f_2(x+ct) \tag{6.22}$$

where f_1 and f_2 are functions of the single arguments $x-ct$ and $x+ct$, respectively. Then, assuming that the wave disturbance is moving in the direction of x increasing, it is only the solution in $x-ct$ which needs to be considered. This solution indicates that the electric field intensity in the y direction is constant if measured at a position which advances in the x direction at the velocity c. The velocity of wave propagation is c.

This does not mean that whatever it is that forms the field is advancing too. The solution shows that, if a detector travelled at velocity c in the x direction, the field intensity would appear constant, whereas, if the detector remained at rest, the field intensity would vary in dependence upon the nature of the wave disturbance.

Now, this theory according to Maxwell, based as it is upon Faraday's observations, explains how it is that electromagnetic waves are propagated at the velocity c, which is also a parameter we find relates electromagnetic and electrostatic units. As is well known, c can be measured in the laboratory without even examining any propagation phenomena. The theory does not explain the mechanics of the aether which give rise to the phenomenon of finite velocity wave propagation. Maxwell's theory is really empirical. It involves a displacement current concept, and it is accepted, even though physicists are reluctant to assign charge in the aether as the source providing the displacement current. In the author's interpretation under review, charge in space–time has been specified. Now, we will proceed to derive the disturbance propagation velocity of the E frame lattice of this space–time medium. The parameter c relating electromagnetic and electrostatic units will be shown to equal this propagation velocity. Maxwell's equations will be used, though it will be sought to interpret them to provide physical insight into the nature of the displacement current.

Initially, the following analysis uses the accepted principles of electron theory. Remember that the analysis is with respect to the electromagnetic reference frame. The medium under analysis is, typically, a system of N electrons per unit volume. The electrons have charge e and mass m, and are all subject to a similar restraining force proportional to displacement distance, denoted ky, where k is the force rate and y is distance. The equation of motion of the electron is:

$$m(d^2y/dt^2)+ky-eV_y=0 \tag{6.23}$$

Here, V_y is the electric field intensity in the y direction. It is given by:

$$V_y=V_{oy}-4\pi Ney \tag{6.24}$$

V_{oy} is the component of electric field intensity due to charge displacement in the aether. These two equations have the following solutions for V_y and y:

$$V_y=\left\{\frac{k-p^2m}{k-p^2m+4\pi Ne^2}\right\}V_{oy} \tag{6.25}$$

$$y=\left\{\frac{e}{k-p^2m+4\pi Ne^2}\right\}V_{oy} \tag{6.26}$$

p is the angular velocity of a simple periodic disturbance imposed upon the system. To eliminate k, it is convenient to put:

$$k = p_o^2 m \tag{6.27}$$

noting that p_o is the angular velocity of a free vibration of the electron, that is, one for which V_y is zero.

From (6.19), as modified to cater for the motion of electron charge, by reference to (6.15):

$$4\pi Ne(dy/dt) + dV_y/dt = -(dH_z/dx)c \tag{6.28}$$

Hence, from (6.24) and (6.28):

$$c\,\frac{d^2 H_z}{dtdx} = -\frac{d^2 V_{oy}}{dt^2} \tag{6.29}$$

From this and the differential of (6.20) with respect to x:

$$d^2 V_{oy}/dt^2 = c^2(d^2 V_y/dx^2) \tag{6.30}$$

By analogy with (6.21), it may then be shown that, since V_y and V_{oy} are proportional, the propagation velocity of the electron medium is:

$$c\sqrt{(V_y/V_{oy})} \tag{6.31}$$

From (6.25) and (6.27), this velocity, denoted v, may be written as:

$$v = c\sqrt{[1/(1+\varphi)]} \tag{6.32}$$

where φ is given as:

$$\varphi = 4\pi Ne^2/m(p_o^2 - p^2) \tag{6.33}$$

This is a formula used in electron theory to determine the refractive index of a medium in terms of the electron systems in its crystalline atomic structure. If no electrical matter is present, the propagation velocity v becomes c because φ is zero. If a plurality of different electrical systems exists, then φ becomes a summation of a series of terms like (6.33).

If, now, we analyse the space–time system itself on the assumption that it contains electrical systems reacting to disturbances just as the electron system described, we see that the unity term in the denominator of (6.32) may itself have the form of (6.33) or be a summation of such terms. To be unity, there must be no dependence upon propagation frequency. Thus, p must be very small compared with p_o. Earlier in this chapter, it was argued that the G frame moved in a fixed orbit. This was consistent with the charge density σ remaining uniform. Wave disturbance, therefore, no doubt involves displacement of the particle lattice. This lattice sets the E frame by its ground state, its undisturbed state. If it is displaced, each particle of charge e will be subject to a restoring force towards its ground position in the E frame. This force will be $4\pi\sigma e$ times the separation distance, making this term the rate k applicable in (6.27). Thus, for the lattice particle of mass m_o:

$$4\pi\sigma e = p_o^2 m_o \qquad (6.34)$$

Since Ne becomes σ, in the sense of this equation, it is seen how φ becomes unity in (6.33) when p is negligible. Thus, the theory of space–time presented will explain why the velocity of electromagnetic waves in free space is the parameter c relating electromagnetic and electrostatic units. It is to be noted that p_o is not equal to Ω in (6.1).

The above account explains why electromagnetic waves are propagated by the space–time lattice at the velocity c. It is important, however, to note that this wave propagation cannot be connected with the electrodynamic interaction of gravitation. Electromagnetic waves are attenuated in inverse proportion to distance from their source. Gravitation is an inverse-square-of-distance phenomenon. We are not, therefore, concerned with the problem of wave propagation by the space–time particle lattice, when we analyse effects at frequencies of the order of Ω. Propagation at such high frequencies involves another mechanism. This is the mechanism by which disturbances are propagated through the medium separating the lattice particles.

In Chapter 1 the effect of accelerating an electric charge was considered on the basis that a wave disturbance was radiated from the surface of the electric charge at the propagation velocity c. In Appendix I it is shown, by equation (4), that the pressure P within an electric charge e is given by:

$$P = e^2/4\pi b^4 \qquad (6.35)$$

where b is the radius of the charge, assumed spherical. If this applies to the lattice particles forming the E frame of space–time, there is the conclusion that a pressure P given by (6.35) pervades space. It is this pressure which holds the lattice particle charges, all quantized at e, together in their discrete quanta, and ensures that all the particles have the same mass. Now, whatever this substance might be, if it exerts a pressure it must contain energy. Since energy is conserved, we may write:

$$\text{Energy density times volume} = \text{constant} \qquad (6.36)$$

If the substance is nothing but mere energy, and the substance is primordial, it cannot be considered as a gas or fluid. It cannot store more energy, nor can it be considered as expanding adiabatically or isothermally. Nevertheless, it can be displaced to fill voids in space. It can expand, if it has space to move into. Let us suppose that there is a pressure P urging the energy into motion at a limiting velocity v. Then, in unit time the energy flowing across unit area will be v times the energy's mass density. The rate of change of momentum will be v^2 times the mass of the energy density. Since this is across unit area, it is the pressure P. Thus, if energy is mass times c^2, as shown in Chapter 1, where c is the propagation velocity of disturbance in this medium, the energy density is c^2P/v^2. Thus (6.36) becomes:

$$\text{Pressure times volume} = (v/c)^2 \text{ times a constant} \qquad (6.37)$$

From the theory of sound propagation in a gas satisfying this relationship, assuming v/c is a constant also, the disturbance propagation velocity is given by:

$$v_o = \sqrt{(P/\rho_o)} \qquad (6.38)$$

where ρ_o is the mass density of the medium. But $\rho_o c^2$ is c^2P/v^2. Therefore, v_o is the velocity v. Also, v_o is c, since all three of these velocities are propagation velocities of disturbances in the medium.

It is concluded that the space surrounding the lattice particles is filled with energy, the density of which is equal to the pressure given by (6.35). A lattice particle has a volume $4\pi b^3/3$. From (6.35), it displaces energy of $e^2/3b$. This energy has the effect of giving buoyancy to the lattice particle. It is exactly half the mass energy of the particle, from equation (6) in Appendix I, and so, the effective mass of the lattice particle is given by:

$$m_o = e^2/3bc^2 \qquad (6.39)$$

This is a most important result. In the following analysis all other charged particles are taken to have a mass given according to equation (6) of Appendix I. The reason is that we will find that the lattice particle m_o is the lightest of all particles. The electron is about twenty-five times heavier and since it displaces about 1/1,840 of the volume displaced by the lattice particle any correction for the buoyancy effect is quite negligible. For heavier particles the effect is even smaller.

At this stage, it has been shown that the space–time system will sustain propagation of disturbances at the velocity c. Electromagnetic waves are carried by the lattice constituent of space–time. Electric field propagation at the velocity c occurs in the medium which surrounds the lattice particles and provides the pressure holding them in balance. It is this mechanism which operates according to the inverse-square-of-distance law. The action of this electric field disturbance is converted by lattice reaction into the Maxwell-type waves, which are onwardly propagated according to the direct-inverse-of-distance law. Lattice reaction is also effective in generating any standing magnetic fields.

Balance in Space–time

We are now ready to consider the dynamic balance in space–time. The lattice particle system and the G frame are in balance. Thus, we may equate the right-hand sides of (6.1) and (6.2):

$$Nm_0 r = \rho(x - r) \tag{6.40}$$

after allowing for the factor N.

In view of the common angular velocity, the kinetic energy of unit volume of these constituents of space–time is proportional to:

$$Nm_0 r^2 + \rho(x - r)^2 \tag{6.41}$$

From (6.40), this is proportional to $Nm_0 rx$ or $\rho x(x - r)$. Now, kinetic energy tends to increase in a dynamic system, just as potential energy tends to decrease. The latter condition fixes x, the total separation distance between the charged systems involved. We take ρ as fixed, as reference. Then, if ρ is greater than or equal to Nm_0, from (6.40) $2r$ is greater than or equal to x. The maximum kinetic energy term is then $\rho x(x - r)$, but the limit condition for r makes r equal to $x/2$. If Nm_0 is greater than ρ or equal to it, from (6.40) $2r$ is less than or equal to x. The maximum kinetic energy term to use is $Nm_0 rx$, but the limit condition then gives r equal to $x/2$, as before. It follows that x must equal $2r$, for the normal undisturbed state of space–time. This then makes the mass densities of the G frame and the lattice particle frame equal, as assumed in the early chapters.

Since the charge continuum which moves with the G frame is deemed to have the velocity c relative to the E frame, to account for its uniform dispersion, the fact that the E and G frames move in the same orbit of radius r means that both move at velocity $c/2$.

From (6.1), putting x as $2r$, and Ω as $c/2r$:

$$m_0c^2 = 32\pi\sigma er^2 \tag{6.42}$$

Since space–time is electrically neutral, if d is the lattice spacing:

$$e = \sigma d^3 \tag{6.43}$$

From (6.42) and (6.43):

$$m_0c^2 = 32\pi(r/d)^2e^2/d \tag{6.44}$$

The evaluation of r/d is the prime task at this stage. It is readily found because, neglecting for a moment the space polarization energy ψ (mentioned at the end of Chapter 4), we know that the spacing between the charges e and σ corresponds to zero electrostatic interaction energy.

The equation of electrostatic energy in space–time, neglecting the self-energy of any particles, is:

$$E = \sum\sum e^2/2x - \sum\int(e\sigma/x)dV + \int\int(\sigma^2/2x)dVdV \tag{6.45}$$

The factors 2 in the denominators are introduced because each interaction is counted twice in the summation or integration. The summations and integrations extend over the whole volume V of the space–time system. x denotes distance between charge. The interparticle lattice distance d is taken to be unity, as is the dielectric constant.

Differentiation with respect to σ allows us to set σ so that E is a minimum. This minimum not only depends upon a condition almost exactly expressed by (6.43), but also depends upon the separation distance between the frames of e and σ.

The differentiation and equation to zero gives:

$$\sum\int(e\sigma/x)dV = \int\int(\sigma^2/x)dVdV \tag{6.46}$$

From (6.45) and (6.46):

$$E = \sum\sum e^2/2x - \sum\int(e\sigma/2x)dV \tag{6.47}$$

This is zero, according to our set condition. To proceed, we will evaluate:

$$\int(e\sigma/x)dV - \sum e^2/x \tag{6.48}$$

as it would apply *if* the charge e were at the rest position. The calculation involves three stages.

Stage 1: The evaluation of $\Sigma e^2/x$ between one particle and the other particles.

Regarding d as unit distance, the co-ordinates of all surrounding particles in a cubic lattice are given by l, m, n, where l, m, n may have any value in the series 0, ± 1, ± 2, ± 3, ± 4, etc., . . . but the co-ordinate 0, 0, 0 must be excluded. Consider successive concentric cubic shells of surrounding particles. The first shell has 3^3-1 particles, the second 5^3-3^3, the third 7^3-5^3, etc. Any shell is formed by a combination of particles such that, if z is the order of the shell, at least one of the co-ordinates l, m, n is equal to z and this value is equal to or greater than that of either of the other two co-ordinates. On this basis, it is a simple matter to evaluate $\Sigma e^2/x$ or (e^2/d) $\Sigma(l^2+m^2+n^2)^{-\frac{1}{2}}$ as it applies to any shell. It is straightforward arithmetic to verify the following evaluations of this summation. S_z denotes the summation as applied to the z shell.

$$S_1 = 19{\cdot}10408$$
$$S_2 = 38{\cdot}08313$$
$$S_3 = 57{\cdot}12236$$
$$S_4 = 76{\cdot}16268$$
$$S_5 = 95{\cdot}20320$$

By way of example, S_2 is the sum of the terms:

$$\frac{6}{\sqrt{4}}+\frac{24}{\sqrt{5}}+\frac{24}{\sqrt{6}}+\frac{12}{\sqrt{8}}+\frac{24}{\sqrt{9}}+\frac{8}{\sqrt{12}}$$

Here, $6+24+24+12+24+8$ is equal to 5^3-3^3.

Stage 2: The evaluation of components of $\int(e\sigma/x)dV$ corresponding to the quantities S_z.

The limits of a range of integration corresponding with the z shell lie between $\pm(z-\frac{1}{2})$, $\pm(z-\frac{1}{2})$, $\pm(z-\frac{1}{2})$ and $\pm(z+\frac{1}{2})$, $\pm(z+\frac{1}{2})$, $\pm(z+\frac{1}{2})$. An integral of $e\sigma/x$ over these limits is denoted $e\sigma d^2 I_z$. The expression I_z may be shown to be:

$$I_z = 24z \int_0^1 \sinh^{-1} (1+y^2)^{-\frac{1}{2}}\, dy$$

Upon integration:

$$I_z = 24z(\cosh^{-1} 2 - \pi/6)$$

Upon evaluation:

$$I_l = 19{\cdot}040619058z \tag{6.49}$$

Within the I_l shell there is a component I_o for which z in (6.49) is effectively 1/8. Thus:

$$I_o = 2{\cdot}380077382 \tag{6.50}$$

Stage 3: *Correction for finite lattice particle size.*

The lattice particles have a finite size. They occupy only a small part of the unit volume under study, but we are dealing with the fundamental constants of space–time and the analysis has to be taken as far as is reasonable.

Equation (6.43) is not strictly true if we allow for the finite volume of the charge e. However, for the purpose of the analysis in stages 1 and 2 it is easier to define e so that it satisfies (6.43). In effect, e is made $e + \sigma V$, where V is here the volume of the charge e. Allowing for this, the particles can be taken as point charges, except for the one at the origin of co-ordinates. Here, we must avoid including interaction energy on the assumption that it is generated *within* the particle volume. The correction term to be subtracted from I_o is:

$$\int_0^b 4\pi\sigma e x\, dx$$

where b is the radius of the particle. This is:

$$2\pi(b/d)^2(e^2/d) \tag{6.51}$$

From (6.39) and (6.44):

$$b/d = (d/r)^2/96\pi \tag{6.52}$$

Thus, in the units of e^2/d, the correction, found from (6.51) and (6.52), is:

$$(d/r)^4/4608\pi \tag{6.53}$$

Now, these three sets of results can be combined to complete the evaluation of (6.48). To relate (6.48) with (6.47), note that the two systems of opposite charge have been displaced relative to one another through the distance $2r$ from the rest position. For each charge e, this involves increasing the electrostatic energy by $4\pi\sigma e x dx$, integrated from 0 to $2r$. This is:

$$8\pi\sigma e r^2$$

or, in the units of e^2/d being used:

$$8\pi(r/d)^2$$

The value of E given by (6.47) may now be written as:

$$E = 8\pi(r/d)^2 - I_0 + (d/r)^4/4608\pi - \sum I_z + \sum S_z \qquad (6.54)$$

The difference between the two summations in this expression is readily calculated by comparing (6.49) with the table of values of S_z. The S terms are all slightly greater than the I terms, but the difference converges according to the following series. It starts with the difference between S_1 and I_1.

$$0{\cdot}06346 + 0{\cdot}00189 + 0{\cdot}00050 + 0{\cdot}00020 + 0{\cdot}00010 \ldots$$

To sum the series, note that the difference terms converge inversely as the cube of z. The matching convergent series, from z of 3 onwards, is:

$$0{\cdot}01350 \left\{ \frac{1}{3^3} + \frac{1}{4^3} + \frac{1}{5^3} + \frac{1}{6^3} \ldots \right\}$$

or:

$$0{\cdot}00050 + 0{\cdot}00021 + 0{\cdot}00011 + 0{\cdot}00006 \ldots$$

This sums to 0·00105. However, note that above we have been dealing with the differences in large terms. Even this matching convergent series may be a little high-valued. Possibly a sum of 0·00100 would be more appropriate. To proceed, it seems better to round off this estimate of the sum of terms for z of 3 and above at 0·0010, and avoid taking the calculation through further digits. Then, collecting these data with (6.50), gives:

$$I_0 + \sum I_z - \sum S_z = 2{\cdot}3801 - 0{\cdot}0663 = 2{\cdot}3138$$

Putting this in (6.54) and remembering that E is zero, if space–time has no priming energy ψ, we obtain an equation in r/d which can be solved by ordinary numerical methods. It is found that:

$$r/d = 0{\cdot}30289 \qquad (6.55)$$

Space Polarization Energy

If space has a polarization energy ψ per unit volume d^3, and ψ is expressed as ψ units of e^2/d, this becomes equal to the expression in (6.54). E is then not zero. Provided ψ is small, it may then be shown that r/d is increased thus:

$$r/d = 0{\cdot}30289 + 0{\cdot}0657\psi \tag{6.56}$$

At this stage, we could proceed by assuming that ψ is zero. Then, the basic constant of space–time, this factor r/d, would be used extensively but would only be approximate. Eventually, our analysis will take us to an evaluation of ψ in terms of quantities deduced from r/d. Then, a better value of r/d can be obtained and the whole process repeated until exact results emerge. In the interests of keeping this analysis as simple as possible, the author proposes to introduce the value of ψ at this stage without proof. Later, it will be derived. It will be shown to be given by:

$$\psi = 0{\cdot}000456 \tag{6.57}$$

measured in units of e^2/d per unit volume d^3 of the lattice. Hence, (6.56) becomes:

$$r/d = 0{\cdot}30292 \tag{6.58}$$

As is seen, the correction is very small. It demonstrates the very stringent accuracy demanded from this theory.

Derivation of Planck's Constant

In Chapter 4 a cubic lattice unit, termed a photon unit, was assumed to be in rotation to develop a pulsating disturbance in atomic systems. Compensation of these pulsations by the motion of an electron was the basis of the Schrödinger Equation. Our next objective is to determine the exact nature of this cubic lattice. Indeed, we will seek to explain why it is cubic in form and why it exists at all.

Rotation of the lattice, meaning rotation of a group of particles which tend to stay in their relative positions, is a possibility. If energy has to be stored in quanta and two such units can have balanced angular momentum by their counter-rotation, it is likely that this can happen. At any rate, it is the assumption which has proved of such value in deriving a physical understanding of wave mechanics in Chapter 4. Also, it is this assumption which sustains the analysis of the magnetic spin moments in the next chapter. Now, to determine the size of the photon unit, we will, only for the moment, make the assumption that there has to be symmetry in three dimensions. This will be proved below. Next, we will assume that the photon unit is as small as possible. To support this assumption, remember from equation (4.18) that the electron which exchanges angular momentum with the photon unit moves at radius $2r$ about the centre of the unit. From (6.58), $2r$ is only $0{\cdot}6\ d$. Thus, for the photon lattice unit to remain a rigid grouping of particles having a lattice spacing d, the unit must necessarily be the smallest possible. Otherwise the changes in angular velocity of the electron at radius $2r$ would cause subgroups of lattice particles to rotate within the main unit. The radius of gyration of the unit, being equal to or greater than d, has to exceed $0{\cdot}6\ d$, but it really should be as near a match as is possible. This makes the determination of the true size of the photon unit a relatively simple task. The smallest unit is one having three-dimensional symmetry matching the two dimensional form shown in Fig. 6.1. The next smallest unit is a 3 by 3 by 3 array of particles as depicted in Fig. 6.2. The circle in Fig. 6.1 denotes the boundary of a sphere

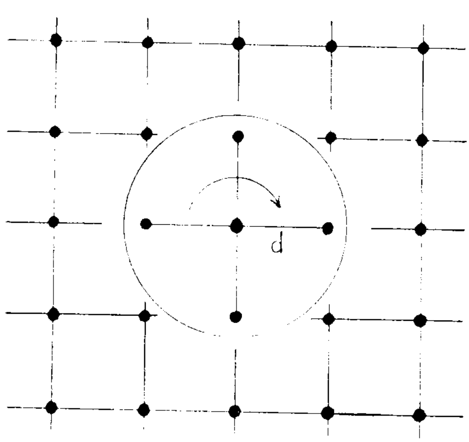

Fig. 6.1

containing the charge belonging to the continuum, of charge density σ. This rotates with the lattice unit and is of such size as to compensate its magnetic moment due to rotation relative to the E frame. A similar sphere of continuum charge contains the array in Fig. 6.2.

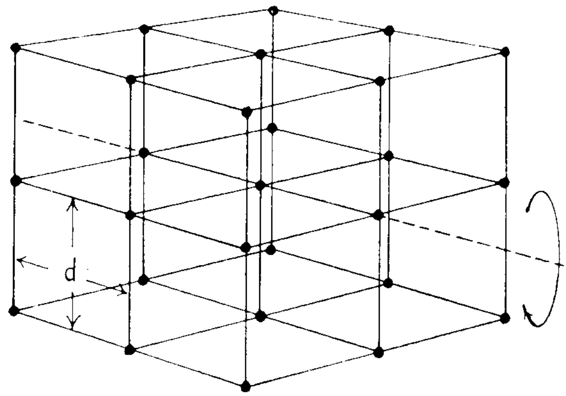

Fig. 6.2

It is not shown. Note that, since the electrostatic interaction energy in space–time is virtually zero, there is no problem about any angular momentum due to such interaction energy. This is provided the lattice and the continuum rotate together. The absence of such angular momentum is probably a more basic feature of the system than any need to balance magnetic moment. Magnetic moment will be balanced, except transiently, but angular momentum is always conserved. This argument really amounts to saying that the only angular momentum possessed by a rotating photon unit is that due to the intrinsic mass of the lattice particles. In effect, however, from an expression such as (6.45) one could say that there are three other angular momentum quantities present but they are mutually compensating. The interaction energy between the particles adds a positive angular momentum. The self-energy of the spherical continuum charge adds a positive angular momentum. The mutual electrostatic energy between the particles and the sphere of continuum is negative and provides the negative angular momentum in the balance. This is important if we explore the problem of the changes of rotation speeds. If the lattice changes its angular velocity by some interaction with the electron, how does the continuum pick up the same angular velocity? If the action is by direct contact, is there a time delay? If it is indirect and operates by magnetic moment balance, is there not then a time delay because of energy transfers with the field medium? Assuming some delay in the process, it is suggested that the preferred photon system should have the best intrinsic ability to conserve its angular momentum transiently when the lattice angular velocity slips relative to that of the continuum sphere. What this means is that if the photon lattice rotates and the continuum sphere does not, then the angular momentum is about the same as it would be if the continuum sphere rotated at the same speed and the lattice did not rotate. In either case, interaction energies are ignored. This applies even between the particles in the rotating lattice because it is matched by some negative interaction energy, and though this latter energy may not be rotating at the same speed it will mitigate to some extent. Our analysis is not rigid here, anyway. The object is to find out which photon unit Nature has chosen, and, as indicated by the comments on radius of gyration, it is a small unit, the likely choice being restricted to those shown in Fig. 6.1 or 6.2

Let Nd^3 be the spherical volume of continuum. The charge corresponding to this is Ne. The electrostatic energy of such a sphere of uniform charge is $3N^2e^2/5x$, where x is the radius of the sphere. The mass of such a sphere is found by dividing by c^2. Then, the moment of inertia calculation becomes a problem, because we have to work out where the mass is distributed, and guess how this mass distribution might move as the charge rotates. To avoid this, let us just suppose that the total mass is about the same as that of the lattice particles encompassed by the sphere, or, more logically, the mass of the number of particles having the compensating charge. In other words, we equate the mass calculated above to Nm_o.

From the above and (6.44):

$$Nm_oc^2 = 32\pi(r/d)^2Ne^2/d = 3N^2e^2/5x$$

Thus:

$$N = 160\pi(r/d)^2x/3d$$

Since Nd^3 is $4\pi x^3/3$, we can find N. (6.58) is used to replace r/d. N is 29·5.

This suggests that the system shown in Fig. 6.2, which has twenty-seven lattice particles, is more likely to exist than the one containing seven particles presented in Fig. 6.1. It also rules out larger photon units, which are unlikely anyway if they have to interact with the electron moving at radius 0·6 d.

The very simple cubic 3 by 3 by 3 lattice is thus argued to be the fundamental photon unit introduced in Chapter 4. Below, it will be shown that three-dimensional symmetry as assumed above is a necessary condition for the moment of inertia of a photon lattice to be independent of the direction of the axis of rotation of the unit. This is consistent with the need to have photon radiation in any direction independent of the lattice orientation of general space-time. Before proving this, we will evaluate Planck's Constant.

The moment of inertia of the photon lattice, when considered to rotate about an axis through the centre and parallel with a cube direction, is $36m_0d^2$. There are twelve particles distant d and twelve distant $\sqrt{2}\, d$ from this axis. Since the standard photon unit, that is one rotating to produce pulsations at the universal frequency of space–time, has an angular momentum of $h/2\pi$ as shown in Chapter 4, we know that the moment of inertia of the photon unit must be $h/2\pi$ divided by one quarter of $c/2r$. Thus, there is a relationship between m_0d^2 and h:

$$36m_0d^2 = 4hr/c\pi \tag{6.59}$$

From this and (6.44), we eliminate m_o and obtain:

$$\frac{hc}{2\pi e^2} = 144\pi\, r/d \tag{6.60}$$

From this and (6.58):

$$\frac{hc}{2\pi e^2} = 137{\cdot}038 \tag{6.61}$$

This is the reciprocal of the fine structure constant. It is exactly the value measured. Hence, this theory has led us to an evaluation of Planck's constant in terms of the charge of the electron and the velocity of light.

We will now prove that the moment of inertia of the photon unit is independent of the axis about which it spins.

Consider co-ordinates referenced on the centre of the unit. Imagine a particle with co-ordinates x, y, z distant p from the origin. Take spin about the x axis. The moment of the particle about this axis is y^2+z^2. This is p^2-x^2. Now take spin about an axis inclined at an angle θ with the x axis. The moment about this new axis is $p^2 \sin^2 \theta$, or $p^2 - p^2 \cos^2 \theta$. Let l, m, n denote the direction cosines of this new axis of spin, relative to the x, y, z axes. Then, the moment about the new axis, found from the direction cosine formula for $\cos \theta$, is:

$$p^2 - (lx + my + nz)^2$$

If now we apply this to a group of particles having three-dimensional symmetry, there is a particle with co-ordinate $-x$ for every one with co-ordinate $+x$. Thus, cross-multiples of x, y and z cancel. The above expression then becomes a summation, thus:

$$\sum p^2 - (l^2\sum x^2 + m^2\sum y^2 + n^2\sum z^2)$$

Cubic symmetry means that it does not matter if x, y and z are interchanged. Consequently, their summations must be equal. Then, since the sum of the squares of direction cosines l, m and n is unity, we find that the expression becomes the summation of $p^2 - x^2$ for all particles in the group. This is independent of the direction of the axis of spin.

Electron Mass

From Chapter 4, when the electron moves at radius $2r$ its moment of inertia in its orbit is equal to that of the photon unit. Hence $m(2r)^2$ is equal to $36m_0d^2$.
From this:

$$m/m_0 = 9d^2/4r^2 \tag{6.62}$$

From (6.58) we then have:

$$m/m_0 = 24{\cdot}52 \tag{6.63}$$

This is a fundamental relation between the mass m of the electron and the mass m_0 of the lattice particle of space–time. The lattice particle thus has a mass of about $3{\cdot}7\ 10^{-29}$ gm. Such particles may have been observed in experimental work, but they have probably been passed by on the assumption that they are "holes". For example, Galt (1961) in a paper on cyclotron resonance presents data of measured power absorption coefficients in bismuth. A small peak occurred in his measurements at different frequencies and in proportion to magnetic field strength. At 24,000 Mc/sec. the peak appears between 600 and 700 oersted. This corresponds to a mass of $He/2\pi fc$, where we assume the electron charge e, the field is H and f is the frequency. The data give a value of mass of about $7\ 10^{-29}$ gm. He stated that this was due to the presence of holes. It is double the mass we have deduced for the lattice particle. Yet, if this can be passed by as a mere hole then perhaps direct evidence of such a particle has been overlooked. On the other hand, it may well be that the basic particle of space–time eludes any direct measurement inasmuch as it may perform a role of reference itself. Its disturbance when in a lattice characterizes a magnetic field. Hence, it may meld into that field and defy detection.

It is of interest to calculate the mass density of the space–time lattice. From (4.1) we know that r is 1·93 10^{-11} cm. From (6.58), d then becomes 6·37 10^{-11} cm. This means that there are 3·87 10^{30} lattice particles per cc. From (6.63) this is equivalent to the mass of 1·58 10^{29} electrons or 144 gm/cc. This is almost exactly that expected from the analysis of Mercury's anomalous perihelion motion in the previous chapter.

It is also worthy of note that if d had come out to be ten times larger than predicted above, the electron population of heavy atoms would have precluded photon formation as described. The photon units of about 10^{-10} cm radius are a perfect dimension on the basis of known atomic sizes. If d were one-tenth that found, it is not possible to accept the angular momentum exchange between the photon unit and the electron while retaining the electron appropriately quantized. Quantitatively, the predicted dimensions of space–time seem to be in perfect accord with what one might term one's sense of things. Some theories lead to quantities which are so far removed from those experienced that it is difficult to accept them on this account alone. This theory has indicated the existence of a particle which is 0·0408 times the mass of the electron. Next, we will examine the other particle, already mentioned. This is the graviton. It will be seen to have a mass which is just right in that it is a little greater than the masses of the basic nucleons. Indeed, the basic principle we are approaching is that space–time comprises a heavy particle form and a light particle form and all matter exists as a kind of transient between these two forms as space–time expands and allows the sporadic degeneration of the heavy particles.

The Muon

In presenting equation (6.38) we introduced the density ρ_o of the energy medium surrounding the lattice particles and keeping the pressure balance effectively binding the charge e of each particle. For each lattice particle the quantum of energy in the medium is the pressure P multiplied by the volume $d^3 - 4\pi b^3/3$. This is the unit volume of the lattice less that occupied by one particle. From (6.35), the energy quantum is:

$$e^2d^3/4\pi b^4 - e^2/3b \tag{6.64}$$

Now, if K denotes the volume of the medium per lattice particle as a ratio to that of the particle, from (6.39) we see that the energy quantum just derived is:

$$Km_0c^2 \tag{6.65}$$

To evaluate K, note that (6.44) applies for point charges e. The equation (6.43) really should be:

$$e = K\sigma d^3/(K+1) \tag{6.66}$$

if e is true charge of finite size. Also, since σ cannot exert force on itself owing to its balance of magnetic and electrostatic force, the finite size of the particle has no effect upon (6.42). The "hole" in σ filled by e does not develop a force component. This means that (6.44) should be increased by the factor $(K+1)/K$. Then, from this and (6.39):

$$d/b = 96\pi(r/d)^2(K+1)/K \tag{6.67}$$

But, K is $3d^3/4\pi b^3 - 1$, so we can use (6.67) to evaluate K, bearing in mind that r/d is known from (6.58). It is found that K is 5062·0. From (6.63) and this result, the value of the energy quantum under study can be evaluated as 206·4 electron energy units. This happens to be the same energy as is possessed by the muon. This meson has a mass some 206·7 times that of the electron.

What this means is that if something happens in space–time to cause a charge e, concentrated in a very small and therefore heavy particle, to expand to become part of the charge σ filling space around the lattice particles, then it must deploy the energy of the muon to provide the energy of the added medium around the particles of the lattice. If space is full, ruling out the general expansion process, the lattice particles must share in a transient compaction. This involves displacement against the same pressure P of space–time and, accordingly, the energy of another muon is stored transiently on the lattice particles. This brings us into a line of thought which imagines a heavy source particle able to release its energy by creating pairs of muons and providing energy quanta which are somehow determined by (a) energy balance, (b) angular momentum conservation, and (c) space conservation. One is led into speculations such as, what is the total mass of electrons and positrons which jointly share a volume equal to that of the lattice particle? From (6.39) and the fact that the electron satisfies equation (6) of Appendix I, the answer is the volume ratio $(m/2m_o)^3$. From (6.63) this is 1,843. We have a mass quantity only slightly greater than that of the proton or neutron. Then, one can speculate on an energy balance equation such as:

$$xg = 2y\,(\text{muon}) + 2xX + yzY \tag{6.68}$$

where x and y are integers and z is either zero or becomes unity if X is 1,843. g is the mass of the source particle in electron mass units and the muon quantity is the mass quantum 206 deduced above. When z is zero X is the size of a particle form produced as a by-product of the reaction. Otherwise, Y is the particle by-product. This is all empirical analysis, but it so happens that there is a value of g which gives the results tabulated below.

x	y	z	X	Y	*Particle*
1	1	0	2,326		$\Sigma^0 = 2{,}326$
1	1	1	1,843	965	$K^0 = 965$
1	2	1	1,843	276	$\pi = 276$
2	1	1	1,843	2,342	$\Sigma = 2{,}342$

The stated masses of the particles are those given in Kaye and Laby Tables, 12th Edition, with the exception of the mass of the pion. This has been put as 276 as the average of the following data sources. They are obtained from Marshak (1952), who has written authoritatively on meson physics.

The mass of the positive pion:

277·4 ± 1·1 (Berkeley workers)
276·1 ± 2·3 (Birnbaum *et al.*)
275·1 ± 2·5 (Cartwright)

The mass of the negative pion:

276·1 ± 1·3 (Barkas *et al.*)

The above table concerns particles which are among the most important in elementary particle physics. It is significant that they come out in such a neat form in the table. More significant, however, is the quantity g. It is 5,063. This is almost the same as the value of K. Indeed, it is $K + 1$.

It is claimed that this result has significance. The basis of equation (6.68) is not explained, apart from the likely involvement of pairs of muons, and a guess at something which has led us to the figure 1,843. Even so, there can be no denying the curious and interesting result developed in the table. Even if the numerical values of certain particle masses are non-integral, there is very close agreement. The mystery becomes even more interesting when one examines the third item in the table. This shows that the energy $g-2$ (pion) is a package of energy surplus to the generation of a pair of pions. If this package of energy is absorbed by the proton, of mass 1,836 units, the resultant composite particle has a mass of 6,347 electron units or 3,245 MEV, when g is 5,063. Now, when protons are supplied to an environment in which pions are being produced, such a particle is actually formed. Krisch *et al.* (1966) have claimed that this reaction produces the largest elementary particle to be discovered. They write: "We believe that this is firm evidence for the existence of a nucleon resonance with mass $3{,}245 \pm 10$ MEV. . . . It seems remarkable that such a massive particle should be so stable."

The author is tempted to claim that the above argument provides strong evidence favouring the existence of an elementary particle of 5,063 electron masses. In Chapter 8 we will see how this can be explained from basic principles. For the moment, our interest must turn to gravitation. This quantum could be the graviton. If it is, we can calculate the Constant of Gravitation from (5.12). From (5.10) and the corresponding formula for the electron, we know that x is a/g, where a is the radius of the electron. From (4.1) and (6.60), r can be eliminated to give:

$$e^2/mc^2 = d/72\pi \tag{6.69}$$

However, from the energy of the electron as given by (6) in Appendix I:

$$e^2/mc^2 = 3a/2 \tag{6.70}$$

From (6.43), we can write (5.12) in the form:

$$G = [6\pi x^4 c^2/ed^3]^2 \tag{6.71}$$

Since x is a/g, and since (6.69) and (6.70) combine to show that a is $d/108\pi$, we can then write G as:

$$G = [4\pi/(108\pi)^3 g^4]^2 (3ac^2/2e)^2 \tag{6.72}$$

Replacing g by 5,063 and putting (6.70) and (6.72) together:

$$G = \left[\frac{4\pi}{(108\pi)^3(5{,}063)^4}\right]^2 (e/m)^2 \tag{6.73}$$

Since e/m is 5·273 10^{17} esu/gm, we can evaluate G. It is found to be 6.67 10^{-8} cgs units.

This is the measured value of G. This theory has, therefore, provided a quantitative and qualitative account of gravitation. All the evidence points to the existence of gravitons, particles of charge e having a mass 5,063 times that of the electron. Further argument, and proof, of this will be provided in Chapter 8, after we have explored in more depth the nature of the atomic nucleus and the processes of matter creation. These involve a deeper study of spin properties and are best treated separately. Further, in Chapter 8, the account of the graviton reaction process from which the mass of the graviton is deduced is a good introduction to cosmic phenomena.

Before leaving this chapter, it is appropriate to summarize the constituents of space–time. Also, we have to determine the value of the space polarization energy. Space–time comprises:

1. *Gravitons.* They have charge e and a mass about 5,063 times that of the electron. They are located in the G frame and they are the seat of the mass providing the dynamic balance for matter and the lattice particles.
2. *The continuum charge* σ. This is uniformly dispersed throughout space. A unit volume of the lattice has enough of the charge σ to balance an opposite polarity charge quantum e. The polarity of σ is the same as that of the graviton charge. This charge is relatively insignificant from the point of view of dynamic mass balance. It moves with, and forms part of, the G frame.
3. *The lattice particles.* These have a charge e opposite to that of the graviton. Each has a mass of 0·0408 times that of the electron. These particles form a cubic lattice which is the electromagnetic reference frame. They are the E frame. They are in dynamic balance with the gravitons. Since the orbits of both frames are almost equal, there are about 124,000 lattice particles in space–time for every graviton. This explains why the graviton charge does not affect the electrical analysis of space–time presented above.
4. *The energy medium.* This is the system of energy density $\rho_o c^2$

which is at rest in the inertial frame and which provides the pressure balance for the lattice particles. It has no charge and it is the medium determining the propagation velocity of electric field disturbance. Its true nature is not understood. Nor is it understood how the heavier particles of charge forming matter or the gravitons, etc., are restrained from expanding to release their energies. They are subject to higher internal pressure than the lattice particles. However, this problem is no weakness. It is a problem confronting any theory which retains accepted laws of electric action.

5. *Electrons.* On the assumption that the lattice particles have negative charge *e*, it is likely that there are electrons in the *E* frame. These have not been introduced above. They are needed to provide a kind of symmetry. There is one such particle for each graviton, that is, there are very few indeed of these particles under normal conditions, so the lattice system is not disturbed. Symmetry is needed because the mass of the continuum charge is effectively zero due to its involvement with the interaction within the lattice. Then, for each lattice particle we have 5,062 units of mass in the energy medium, with charge balance from the continuum. Now, if we have the electrons as suggested, we have about 5,063 units of their mass in the graviton and the facility for direct charge balance. Without the electron, the graviton could not migrate relative to the lattice, to spread its mass effect, unless it moved a lattice particle with it.

   It is suggested that the electron is paired electrically with the graviton and migrates with it.

The presence of the electron in the *E* frame provides a minor disturbance to the dynamic balance of the system of space–time. If we think in terms of kinetic energy and centrifugal force balance by electrostatic interaction with the *G* frame charge, we see that the electron tends to expand the *E* frame orbit because it is heavier than the lattice particles. The interaction between the electrons and the lattice particles will keep the electron in place, in the sense of the harmonious motion component of space–time. It must, if the electron is to be as near to rest in the *E* frame as is possible. However, if the electrons urge expansion of the *E* frame orbit, the lattice particles react to contract the orbit. It has been contended that such contraction is not possible because electrostatic interaction energy cannot be zero anywhere in space. Therefore, there must be only outward expansion and this must be due solely to the dynamic effects of the electron. The electron adds energy, in effect, to the interaction energy of space–time. It sets up a polarization energy equal to the electrostatic energy corresponding with this small orbital expansion. Again, since mass varies to keep mass energy constant as c varies, as was discussed in Chapter 5, we need only consider one of the energy forms, either electric or kinetic. This leads to the energy $\frac{1}{2}m(c/2)^2$ for each electron. The E frame moves at this velocity $c/2$. Since there are 5,063 (m/m_o) lattice particles per electron, the energy per lattice particle is:

$$\frac{m_0c^2}{8(5{,}063)} \tag{6.74}$$

Then, this has to be doubled because the G frame provides a centrifugal balance and it must, therefore, contain the same energy. Doubling (6.74) we have, from (6.44), a total priming energy per particle of:

$$\left(\frac{8\pi(r/d)^2}{5{,}063}\right) e^2/d \tag{6.75}$$

Substituting the value of r/d from (6.58), this becomes $0{\cdot}000456(e^2/d)$, as presented in equation (6.57). This energy is enough to sustain a magnetic field of the order of 10^{10} oersted. Therefore, although it is small enough not to cause any significant disturbance of the space–time system, it will, nevertheless, not unduly limit the ability of space–time to carry strong magnetic fields.

Summary

In this chapter the difficult problem of analysing the aether has been confronted. The zero electrostatic energy condition has been the entry point to the subject. Minimum energy has been avoided, because it is relative, whereas space–time has to be absolute. This has given us the parameter r/d. This key quantity enables the evaluation of basic energy quanta. Masses matching those of the muon and other elementary particles emerge from the arithmetic quite easily, though a complete physical understanding has to await us in Chapter 8. The fine structure constant, and, therefore, Planck's constant has been evaluated exactly. The constant of gravitation has also been evaluated exactly. These results can but speak for themselves. The chapter has also offered an account of the mechanism of the finite propagation velocity c. This is important qualitatively because it has helped us to develop a comprehensive understanding of the constituents of pure space–time. In the next chapter, our attention is turned to the atomic nucleus and the quantities involved in atomic theory. We will seek to verify the concept of the deuteron presented in Chapter 1. The mass of the neutron and the proton will be evaluated. The results are as remarkable as those in the above chapter, particularly as we will go on to evaluate the magnetic spin moments of the particles under study. The difficult part of this whole work has been covered in this Chapter 6. It is the real core of the whole theory in this book. It is a theory of the aether, an unpopular subject, but an inevitable one. It is difficult to accept, perhaps because, in a sense, truth can be harder to believe than fiction. Yet, any statement is fiction until shown to be truth.

7. Nuclear Theory

Electron-Positron Creation

In Chapter 4 the process by which photons transfer momentum was introduced. When a photon event occurs an electromagnetic wave is propagated and a momentum quantum h/c times the radiation frequency ν is imparted to space–time by matter releasing the photon. It is a statistical possibility that the reverse event will occur anywhere in the wave region. The likelihood of a photon being intercepted in this way probably depends on the wave amplitude and on the rate of flow of momentum locally. Another way of looking at this is to regard space as full of energy. If it contains a uniform distribution of energy, say E_0 per unit volume, and is a veritable sea of energy which is ruffled by wave disturbances, the waves may travel at the high propagation velocity c but the displacement of the energy E_0 to convey momentum will be slow. If a photon traverses a particular unit volume in unit time, the energy E_0 in this volume (of mass E_0/c^2) will be moving at a velocity $h\nu c/E_0$ to convey an energy quantum per photon of E_0 times this velocity divided by the photon velocity c. This energy quantum is, simply, $h\nu$. Hence, the energy-frequency relationship of Planck's law $E=h\nu$.

Since E_0 tends to be uniform, photons "tend" to move from their source to where they are absorbed. Energy quanta are merely exchanged with the energy content of space–time in these photon events. One can say that energy is transferred, but this transfer is indirect and energy certainly does not travel at the velocity c. If it did it would have infinite mass, which would be absurd. The wave travels at the velocity c. Momentum quanta are transferred, as is energy, via the space–time medium. However, momentum is a vector quantity and, although statistically the preservation of the uniform energy distribution in space will bring about momentum balance, it is not likely that a simple energy distribution mechanism can assure that all photons received have the same momentum vector as one emitted. Again, this leads to speculation and we will not dwell on this here.* The point

* Enough was said on page 76.

has been made that the photon mechanism involves emission and absorption of photon quanta in equal numbers if there is not to be a build-up of energy in space–time.

When we consider photon events involving creation or annihilation of electron-positron pairs there are not only the questions of energy balance and momentum balance but, in addition, the problems of what happens to the electric charges and where they come from. These actions are photon events. The photon frequency is given by $mc^2 = h\nu$, since two photons (or gamma rays) are involved in the reaction. Now, it is absurd for anyone to think that two electric charges, one positive and one negative, can possibly vanish into nothing. If this could happen there would be no physics because everything, if it ever existed, would be gone in one big bang. It is nonsense to think that the energy available could recreate charge and matter. There would be no structure, no nuclei on which to rebuild the system. Without the lasting existence of the discrete element of charge e we have no firm foundation to hold the physical universe together. Mass can vary and can come in numerous basic forms. The velocity of light varies according to the media it traverses and it even varies in free space. Planck's constant appears invariable, but would it if e varied? Physics and our existence depend upon something remaining constant and the electron charge is about all we can look to as providing this anchor. The electron and the positron might interact to become something else but their electric charges are conserved and at least one, be it the charge of the electron or the charge of the positron, must retain its discrete form.

Having declared this we have an additional constraint governing the photon events involved in electron-positron annihilation and creation. We have also the constraint introduced in Chapter 1 and discussed in detail in Chapter 6. The volume of space available to house electric charge is limiting. This tells us that if an electron and a positron change into some other particle form, by expanding, then similar particle forms elsewhere must probably contract to create an electron and positron at that other location. If these two events do not occur simultaneously, the adjustments of the structure of space–time will need extra energy to act as a buffer. The transmutations involving electrons and positrons do take place in a highly energetic environment and this buffer action can be expected. However, on balance it is to be expected that for every electron-positron annihilation there is a matching electron-positron creation elsewhere. The process is akin to the photon transfer and, via the photon actions, momentum and energy are balanced also.

With this introduction we can say that when an electron and a positron annihilate one another they meld into space–time, the negative charge of the electron becoming a particle of the E frame lattice and the positive charge of the positron melding into the uniform continuum of charge density σ. It follows that the energy needed to create an electron and a positron is not, in matter terms, $2mc^2$. It is less than this because the constituent elements from which they are created have energy themselves. However, when we think of energy transfer and momentum transfer we have to remember that the adjustment in physical size of the background constituents in space–time cause supplementary energy and momentum transfer exactly as if the $2mc^2$ energy was involved.* Thus, the frequency of the gamma radiation is exactly the frequency we would expect if there were total annihilation. This not only meets some of the perplexing philosophical aspects of this problem but, in addition, there is quantitative evidence in direct support of the theory just propounded. This will be presented below when we explain the results of Robson's experiments.

Mass of Aggregations of Electric Charge

In Chapter 4 it was noted that mass can vary according to its state of motion with the E frame of space–time. In this context the reader is reminded that the relative velocity of the space–time frames can vary slightly, adjusting the speed of light, and since energy ($E = Mc^2$) is conserved it follows that mass may vary. The E and G frames are therefore reference frames for mass quantities. The intrinsic mass energy of any particle is the same whichever of these two frames it occupies. Thus, if we take positive charge in the G frame and negative charge in the E frame and these exist at these locations in discrete particle form, we have no difficulty analysing their respective mass properties. The problem comes when we consider the mass contribution of their mutual electrostatic interaction, particularly when they come together to form a composite mass aggregation in the E frame. If we know that the zero-reference ground state is with positive charge in the G frame and with negative charge in the E frame, the change of electrostatic energy in coming together is

* See also discussion on page 204.

calculable and the net mass energy of the aggregation can be evaluated. If we take the ground state to be their separation to infinity, as is normal in physical theory, we have postulated something which is out-of-line with reality. If we wander into philosophical argument and imagine that the universe came about by all electric charge starting at infinite separation and coming together, we face enormous problems. If everything started compacted together and then separated with a bang the analysis is even worse. It seems so neat to have derived a system of space–time in which an E frame formed by practically all the negative charge is effectively displaced by a definite distance from a G frame formed by practically all the positive charge. It seems logical that at the start of things, before some of this charge got out of place to create matter, all the negative charge was effectively spaced by the same distance from all the positive charge. However, logical or not, there is experimental evidence available to demonstrate that the ground state for mass calculation of aggregations of charged particles is the condition in which opposed particle pairs are each separated by the separation distance of the E and G frames of the space–time system. This will now be presented in a more detailed analysis of the deuteron.

The Deuteron Reaction

At the end of Chapter 1 the form of the deuteron was discussed. It was shown that if it comprises electrons or positrons or both in combination with heavy fundamental particles and all have the charge quantum e then there is one favoured aggregation which could be the deuteron. This aggregation has a binding energy matching that actually measured. In this chapter this approach is taken further to develop a theory of the atomic nucleus and other basic particle systems. It is also to be noted that at the time of writing this book the author has not attempted to take the scope of this research further than that described in this chapter. The further potential of the theoretical approach being presented has, therefore, not been probed, although it does look highly promising.

Fig. 7.1 shows possible forms of the neutron and proton, as well as the deuteron. Also shown is the expression for the mass of each particle in terms of the interaction energy quantities E_1, E_2, etc.

In the case of the deuteron, E_5 has been evaluated approximately as $-4{\cdot}375\ mc^2$. This approximation is due to two factors not allowed

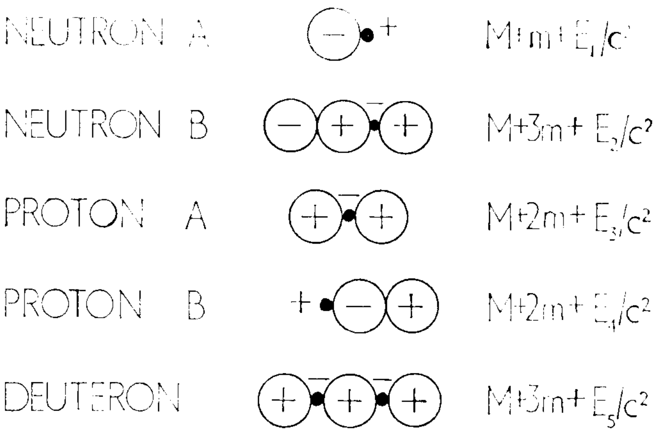

Fig. 7.1

for in the analysis. Note that mc^2 is the rest mass energy of the electron or positron. M is the mass of the fundamental heavy particle deemed to be present in these basic particle aggregations. This heavy particle is termed an H particle.

Since the mass M is about 1,836 times that of the electron, and since the radius of the H particle, being inversely proportional to mass, is 1/1,836 that of the electron, the particles forming the deuteron are spaced a little further apart than was assumed in Chapter 1. The result is that the estimated binding energy is reduced in the same ratio. The corrected value of E_5 is then $-4{\cdot}373\ mc^2$. Next, we need to consider the ground state correction. When the deuteron is broken by gamma radiation its constituent parts do not go off to infinity before recombining in another form. However, there is a fairly definite cut-off value of the gamma ray frequency which will disrupt the deuteron and this suggests that there is a fairly definite separation of the constituent particles which has to be reached before the transmutation is triggered. According to Wilson (1963), the measured binding energy of the deuteron is 2·22452 MEV. Data sources differ on the proper conversion of MEV to units of mc^2, but this measured binding energy seems to be approximately $4{\cdot}352\ mc^2$. The difference between this quantity and the theoretical value $4{\cdot}373\ mc^2$ is $0{\cdot}021\ mc^2$ and can be taken as the error in assuming separation to infinity in the theoretical calculation. We take this as experimental evidence from which to deduce the spacing of the opposed-charge pair elements in the ground state. Thus, the three positive charges will go to their ground state each pairing with a negative H particle or, for balance, an electron to form three particle pairs of interaction energy e^2/x. If we equate $0{\cdot}021\ mc^2$ to $3e^2/x$, we find the separation distance x from the experimental data. This shows that x is close to $2r$, as expected, because $3e^2/2r$ is, from (4.1), $3amc^2$, where a is the fine structure constant. Since a is 0·007298, the $2r$ spacing would give a correction $0{\cdot}022\ mc^2$.

This result is remarkably close, having regard to the fact that it relies upon such a small difference between the measured binding energy and the uncorrected estimate from this theory. It must be taken as giving clear support for the postulated separate E and G frames of the space–time. Further, the analysis of the mass of the deuteron has been shown to be rigorously applicable. The deuteron binding energy is predicted by the theory with extreme accuracy and this encourages the further analysis of other particle aggregations.

Experiment shows that when the deuteron is disintegrated a proton and a neutron are produced. This leads us to understand the composite nature of these particles. A step to be taken at this stage is to realize that for any stable nucleon to change its form, except transiently, there has to be a fundamental change in character of at least two of the constituent particles. The change we contemplate is one in which the energies of two particles of different mass are exchanged. This will be termed particle inversion.

Particle Inversion

Particle inversion is depicted in Fig. 7.2. Here, a positive H particle and an electron interchange energies to form a positron and

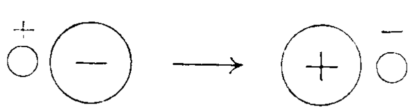

Fig. 7.2

a negative H particle. This can only occur in a highly energetic environment, but when it has occurred the individual particles have adopted a stable form. Overall, there is no total energy change or change in volume of space occupied. Charge is conserved. The physical process has involved some other particle in the environment becoming compacted as it stores energy supplied. This makes a volume of space available which allows the H particle to expand and so release some of its energy. The electron can take a little of this energy and be compacted a little in this process. The form to which this system will revert when balance is restored will probably depend upon which of the two particles, the H particle or the electron, is physically the larger when the reversion process begins. This action is, of course, highly unstable and it has to be remembered that there is no freedom for the various particles to adopt any mass value by appropriate sharing of space and energy. Fundamental particles have discrete forms and, although interchange between these discrete forms is possible, there are a limited number of such forms which can be adopted by a stable particle. We exclude unstable systems and mere particle aggregations in considering this limited number of particle forms, because, as is well known, there seem to be numerous varieties of elementary, though unstable, particles and there are many isotope nuclei. The important point under review is that unless there is particle inversion the disintegrated elements of a particle aggregation will come together again to form the same unit.

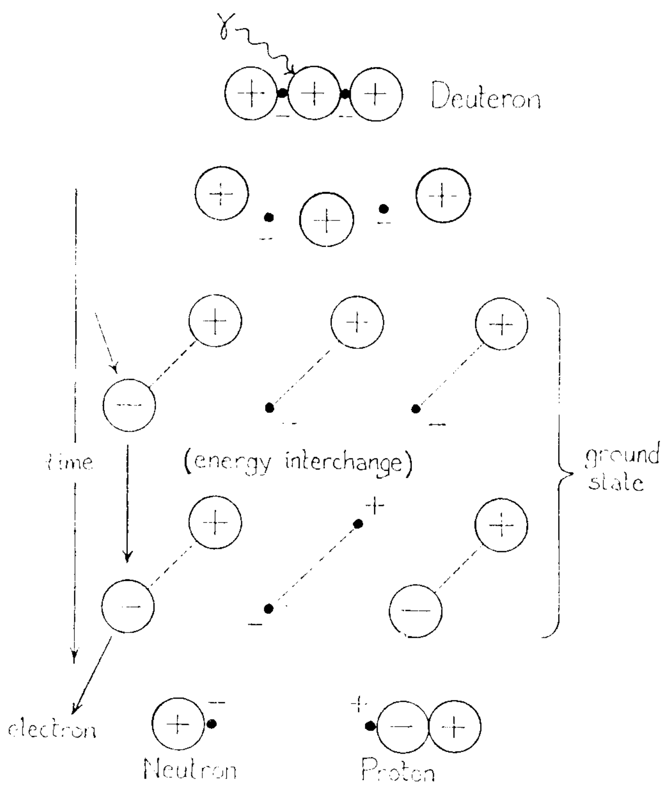

Fig. 7.3

This leads us to the sequence of events depicted in Fig. 7.3. A gamma ray γ acting on the deuteron results in kinetic energy being added to the deuteron. At a certain stage in the process energy inversion occurs, as noted, and this results in there being two heavy H particles of opposite polarity. This is facilitated if it occurs in the ground state, as depicted, because there can be balance, at least transiently, in a dynamic sense if there is a heavy H particle in each of the E and G frames. When this particle system reverts to a normal state we find that the product is a proton and a neutron. We are, therefore, able to investigate the forms of these newly-formed particles.

The Proton

The H particle cannot exist alone for very long. The reason is that an electron or positron, whichever has opposite polarity, will combine with it to form an aggregation having even less energy than the H particle itself. The binding energy exceeds in magnitude the rest mass energy of the electron. Such a neutral system must eventually come into collision with another charged particle. Then, further combination will occur because the total energy of the aggregation can be less than that of its constituent parts.

Referring to Fig. 7.1, for neutron A we can calculate E_1 as approximately $-1{\cdot}5\ mc^2$. This follows because the electrostatic energy of the electron is $2e^2/3a$, where a is its radius, and the electrostatic energy of the coupling between the electron and a point charge e at its surface is $-e^2/a$. This makes E_1 1·5 times the rest-mass energy of the electron. For proton A, E_3 is $-3\ mc^2$, doubling the above because there are two positrons involved, plus the interaction energy between the two positrons of $0{\cdot}75\ mc^2$, because they are at a spacing of $2a$. Thus, E_3 is $-2{\cdot}25\ mc^2$. Similarly, for proton B, E_4 is $-1{\cdot}75\ mc^2$.

Since the binding energy of proton A is greater than that of proton B, proton A is more stable. However, there is a much higher probability of forming proton B. This is because in an environment of H particles a combination of such a particle with an electron-positron pair is far more likely than a combination with two electrons or two positrons. Also, there are less positrons than electrons available in free form. When we discuss the origin of the H particle we will see that it is formed by pairing with an electron or positron of opposite polarity. More electrons implies a greater likelihood of forming the positive H particle initially. Then, we have the increased likelihood of combination with the easily induced electron-positron pair. A less likely event is the combination of the positive H particle with two electrons to form an anti-proton of form A. Least likely, is the formation of proton A.

Following this line of reasoning, we have presented in Fig. 7.2 a proton form B as the product of the deuteron reaction. Therefore, the negative H particle formed by inversion has gone into the neutron product. Before discussing the neutron and neutron decay, it is to be noted that we have deduced a relationship between the mass of the H particle and the mass of the regular proton. Since E_4 is $-1{\cdot}75\ mc^2$, the proton mass, from Fig. 7.1, is $M + 0{\cdot}25\ m$. Thus, the mass of the H particle is less than that of the proton by 0·25 electron mass units. Since, later, we will deduce the mass of the H particle from the teachings of this theory, we have thereby explained the mass of the proton. Note that spin is something which depends upon what is happening to a particle. When the proton is in an atom it has spin properties because of its interplay with the photon units and electrons in the atom. When the proton is isolated, spin cannot be precluded because it might depend upon what the proton brings with it from wherever it has been. Proton spin will be dealt with in detail later in this chapter.

The Neutron

It has just been stated that the positive H particle is the more fundamental. It is the most likely one to be formed. The fact that the deuteron models shown in Fig. 1.3 of Chapter 1 all comprise positive H particles with the exception of model C may seem inconsistent. In discussing the proton we argue in favour of the one having the least binding energy on the grounds that the H particle in positive form has abundance and ease of combination. Why are things different for the deuteron? Why did we not choose between models A, B and D and ignore C, the one with the negative H particles. The reason is clear, now that H particle inversion has been explained. H particles are the origin of matter. They are as fundamental as electrons and positrons. Preponderantly, they are produced in positive form. They first form neutrons by aggregation with electrons or protons by aggregation with electron-positron pairs. Indeed, as will be shown, H particles can, in fact. be actually created in their association with an electron-positron pair. If anything, one would expect the proton really to be formed in much greater abundance than the neutron. It is easier to develop an electron-positron pair if there is an inflow of energy creating matter. Electrons are not produced in isolation. So far as they do exist they can combine with the positive H particle to form a neutral aggregation and then this will join another electron to form an anti-proton because this anti-proton has the least total energy compared with the neutron or the normal proton and has also the strongest binding energy.

The result of this is that the process of matter creation has to be explained in terms of the creation of an abundance of protons of form B with a few anti-protons of form A. In an energetic environment some of these protons and anti-protons will undergo inversion and then combine to form the deuteron as illustrated in Fig. 7.4. Some protons will couple with an electron to form a hydrogen atom or go into the nucleus of a heavy atom. Some protons will undergo inversion and then aggregate with an electron to form a neutron of the form B, shown in Fig. 7.1. Then these will probably go into the formation of heavier atoms or decay back again by ejection of an electron. The anti-protons are possibly preserved until they invert, whereupon they are captured by inverted protons to form deuterons. If the protons and anti-protons aggregate before inversion of the latter they form something less stable than the deuteron and the process of disruption and regeneration can be expected to occur. In the basic matter creation process, the main product is the proton B, the neutron B and the deuteron according to model C in Fig. 1.3 or as shown in Fig. 7.1. Fig. 7.4 shows how a proton and an anti-proton may invert and combine to form the deuteron, ejecting an electron. Then, with the input of a gamma ray, it is shown how this deuteron disrupts to form proton A and a neutron. The neutron may invert and couple with an electron-positron pair in view of the energy available and then may eject an electron, decaying into a proton B. Similarly, the proton A may invert to develop proton B. If the reaction does not go in the way outlined in Fig. 7.4, what are the alternatives? Firstly, could the proton combine with the anti-proton? It might form a particle aggregate, electrically neutral overall, and of the order of mass of the deuteron. Now, it will be contended* that any particle aggregate which has a mass of the order of three or more times that of the proton and which is highly compacted cannot be

* See page 203.

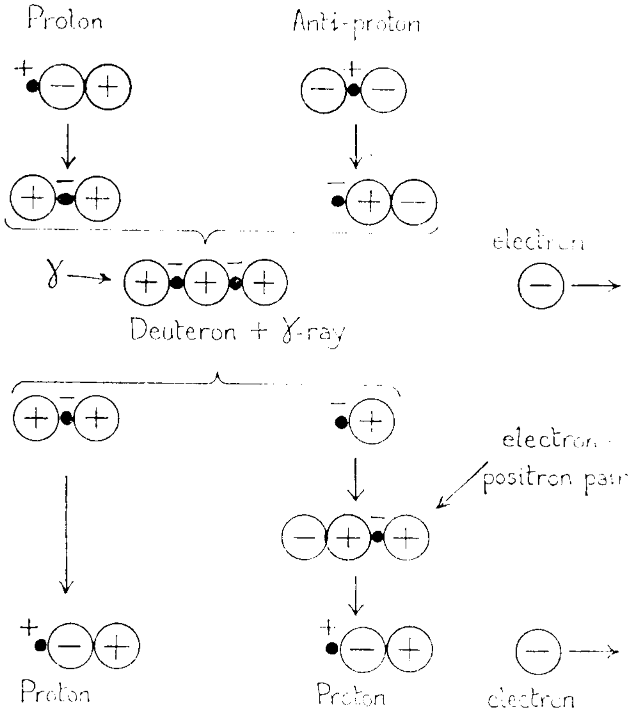

Fig. 7.4

effectively balanced by the interaction of gravitons in the G frame. Two gravitons separated by the lattice dimension d of space–time might share in the balance of a double-proton sized particle, but it is unlikely that three could co-operate in this way. Thus, since we shall later see that one graviton is needed per proton mass unit, we have to preclude aggregations of three or more H particles of the same polarity. We allow but one, the most stable, aggregation of two such particles. At this level the most stable is the deuteron according to model C in Fig. 1.3. To keep the analysis general, but at the level of mass of the deuteron, we can show that model C is favoured even if we involve H particles of opposite polarity in the selection. The mass level requirement is dealt with by allowing the H particles to be no closer than the diameter of an electron. In Fig. 7.5 several possible combinations including two H particles are shown and the total mass value applicable to each is given. None has as low a mass as the deuteron according to model C.

If the proton and anti-proton of Fig. 7.4 combine directly we expect the aggregation shown in Fig. 7.5(b). If the proton inverts its form and combines with the anti-proton the model shown in Fig. 7.5(c) results. If the anti-proton inverts and combines with the proton another model not shown is produced, but all have greater total mass than that depicted in Fig. 7.5(e), which is the model C deuteron. It is a similar story when we consider the possibility of combinations of the products of the deuteron when disrupted by gamma radiation. If anything forms having a mass approximately that of the deuteron it must decay into a deuteron. Effectively, the gamma radiation is dispersed without an end product. If there is an end product we would expect protons and neutrons (in form B) because these are the product of the basic matter creation reaction. These emerge from nuclear processes. Neutrons of the form B have transient stability. They decay via inversion into proton B and an electron.

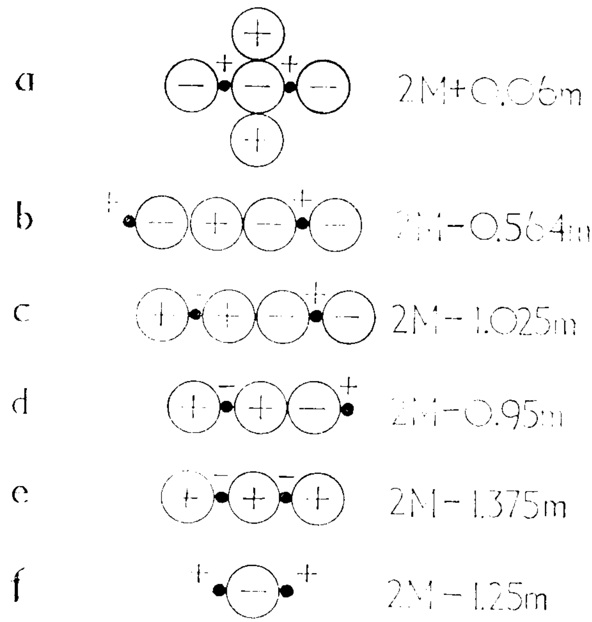

Fig. 7.5

An interesting speculation is whether the deuteron with all polarities reversed, the anti-deuteron, could form from two anti-protons or from some products of the reaction. Let us assume that the answer is affirmative. It is unlikely to happen because the anti-protons are scarce, but it can happen. The result could be an atom with a negative nucleus and a satellite positron. Such an atom would be a misfit in the system of matter we know. Probably such an atom would interact with a normal atom, with the electrons and positrons around their nuclei wiping one another out to develop energy which would stir up more reactions and work the "anti-bodies" out of the system. In the end, only one form of atom can win and that is apparently the one we have assigned a positive nucleus.

The deuteron mass augmented by gamma radiation which puts it into the ground state is simply $2M + 3m$. Then, from the known reaction:

$$D \rightarrow P + N$$

which indicates that the deuteron D converts to a proton P and a neutron N, we can deduce the mass of the neutron. We note that the mass of the proton is $M + 0{\cdot}25m$, as already shown, but subject to a small correction. The mass of the deuteron is really $2M + 3m - 4{\cdot}373m + 3\alpha m$, the latter term being the ground state correction due to the triple pair of charge elements. Similarly, the mass of the proton B is $M + 2m - 1{\cdot}75m + 2\alpha m$, because the ground state correction arises from interaction between two positive charges in the G frame and two negative charges, if we include the transient electron. in the E frame. It follows that the mass $2M + 3\ m$ available can go to create a proton and will leave mass $M + 2{\cdot}75\ m - 2am$ as the mass we can associate with the neutron. Compared with the proton, we find that the neutron is heavier by $2{\cdot}5\ m - 4\alpha m$, or $2{\cdot}4708\ m$. This is, of course, pure theory. An exact check with experiment is not possible because the absolute masses of these two quantities are not known to sufficient accuracy. Roughly, however, the predicted value seems correct. For example, if the proton-electron mass ratio is, say, 1,836·2, the neutron-mass ratio should be 1,838·67. These figures are fairly representative on existing data sources.

If we consider neutron decay, there is a check on the analysis. The neutron can produce a proton and eject an electron, as mentioned above. However, as Fig. 7.4 shows, it has to create and absorb an electron-positron pair. This returns us to the rather complex problem of the energy features of space–time. It was stated early in this chapter that the energy needed to create an electron and a positron is not, in matter terms, $2mc^2$. It is less because the constituent elements from which they are created have energy themselves. We have to digress a little to analyse this.

Firstly, the origin of the electron-positron pair is the lattice particle and a unit volume of continuum in space–time. As was explained in Chapter 6, there is a difference between mass balance and energy balance when we think of these elements. Energy in the form of lattice particles has its proper measure of mass but these particles move in a medium which itself has mass. There is a certain buoyancy effect, the result of which is that dynamic balance in free space comes about from energy in the *G* frame which is only half that in the *E* frame, as far as the relatively large lattice particles only are concerned. Hence, if we take four units of energy from the lattice particle system we take two from the *G* frame system, and we can deploy these six units of energy to create matter and an equal energy balance in the *G* frame. Hence, for each lattice particle and its related *G* frame continuum substance deployed to create the electron and the positron there is available from space–time the energy of 1·5 lattice particles, half of which goes into matter form. That is, the energy of 0·75 lattice particles or $0{\cdot}75(2e^2/3b)$, where b is the radius of the lattice particle, is released to matter in the electron-positron creation process. From the equation (6.39) this is $1{\cdot}5\ m_0c^2$, where m_0 has the value of 0·0408 m, as already shown.

Thus, the energy needed to generate an electron-positron pair corresponds to a mass of $2m - 0{\cdot}0612\ m$ or 1·9388 m. From the neutron we have 2·4708 m. If 1·9388 m of this is used to create an electron and a positron, and we allow for the fact that the mass m of the positron has been included already in the mass assigned to the proton, we must subtract 0·9388 m from 2·4708 m to obtain the mass of the surplus energy. The surplus energy is, therefore, $1{\cdot}532\ mc^2$ and this is released alongside the electron and the proton as a decay product of the neutron.

This energy quantity is 0·782 MEV, and this happens to be *exactly* the value measured by Robson (1951) from end point measurements in the beta spectrum derived from neutron decay. This result shows that the theoretical approach we are following has substantial experimental support. The minor ground state correction needed to understand the exact binding energy of the deuteron, and the energy corrections needed to understand the role of electron-positron creation in neutron decay, both give direct verification of the space–time system on which this whole theory is founded. These exact quantitative results are to be followed by many more in this chapter. Next, we will calculate from basic theory the mass of the particle H. Knowing this mass, we have, from the above analysis, the mass of the deuteron, the proton and the neutron.

The Origin of the Basic Nucleons

To explain the formation of matter as we know it, it is necessary to explain the origin of the basic nucleons, the H particles of the above analysis. The quantization of angular momentum is basic to atomic systems. With this in mind, it can be assumed that in a highly energetic reaction in space–time where nuclear actions are in process almost any energy quantum between that of the graviton and that of the lattice particle can be formed. However, even transient stability requirements pose the need for appropriate disposition of quanta of angular momentum. Owing to angular momentum criteria, certain energy quantized systems are favoured and from these certain stable particle forms can develop. Both the neutron and the deuteron featured in the above analysis contain a negative H particle. To be formed from space–time, the H particle is likely to come from the energy released by an expanding graviton. The graviton provides the gravitational property of the space–time lattice, even in the absence of matter. This is necessary in view of the argument leading to equation (5.6) in Chapter 5. The E frame has gravitational effects according to its mass density. Thus, when the graviton expands, and so loses energy and mass, it is less able to balance mass in the space–time lattice. Graviton expansion must, therefore, accompany some break-up of the lattice. Now, all that this means is that the translational motion of a space–time system and graviton expansion both require lattice particles to be freed from their orbital motion with the E frame. Graviton expansion implies release of energy. This implies the formation of matter. Hence, translational motion of space–time has some fundamental association with the existence of matter. To provide dynamic balance and gravitational effects in an undisturbed space–time, the graviton must, before expansion, be effectively compacted through a definite volume from a gravity-free reference state. The compaction of the graviton through a certain volume produces a related electrodynamic effect causing gravitation. If the graviton provides a basic gravitational effect according to the mass density of the space–time lattice, it must already be compacted through the related volume. Since G is, apparently, the same for gravitation between space–time and matter, the volume compaction of the graviton from its zero-gravitation state to its normal condition must have a ratio to the graviton mass equal to its incremental rate of volume compaction to mass ratio. From simple analysis based on equation (5.10), it can be shown that the total volume compaction of the graviton is three times its final and normal volume. In other words, the action of balancing the space–time lattice causes each graviton to be a compacted version of its gravity-free form and to occupy only one-quarter of its gravity-free volume. The corresponding energy and mass states of the graviton are in the ratio of the cube root of one quarter to unity. Thus, if the mass of the graviton is 5,063m in the normal gravitating state, it is 3,189 m in the non-gravitating state, that is, 1,874 m less.

What this tells us is that, when a part of the lattice is displaced to the inertial frame to form free particles accompanying translational motion of the lattice, there is dynamic out-of-balance allowing graviton expansion to release energy in quanta of 1,874 mc^2. The value of G has to be the same throughout such transitions, otherwise there would be problems explaining loss of gravitational potential. Hence, a quantum condition is imposed upon energy release.

Remember that in deriving equation (4.4) it was assumed that any angular momentum of the G frame was part of the zero angular momentum balance of a particle in the E frame. When this part comes out of its E frame orbit it deploys the corresponding orbital angular momentum from the G frame graviton to cancel its spin. This applies to the electron, as was shown in Chapter 4. It may also apply to the lattice particles. Hence, the release of the energy by the graviton in the manner just described does not release any angular momentum so as to cause a surplus. The graviton itself has no spin. Furthermore, since the graviton has no spin and since the freed lattice particles or electrons, in the sense of Chapter 4, have no spin either, the basic formation of matter occurs under zero-spin conditions.

Now, without elaborating further on the reasons, let us assume that a package of energy of up to 1,874 mc^2 is nucleated by a positive charge e and that an orbital electron having the basic angular momentum $h/2\pi$ goes into orbit around it. Note that the energy need not be wholly associated with the positive charge. It could develop electron-positron pairs by its catalytic action in promoting such events in space–time. We may assume that most of the energy does find itself stored by the positive nucleating charge.* Then, we have a

* In Chapter 9 we will discuss the source of this positive charge. As will be explained, it is a positron. The source of the positron can be better understood when certain cosmic properties have been analysed.

simple problem. The nucleus thus formed needs to have some angular momentum itself. How does it get it? A dynamic system has been formed. There has to be balance. Space–time is not reacting in this case to provide the balance. The lack of angular momentum is the root of the problem anyway. Does it share some of the angular momentum with the electron. If so, how? It is not as if the electron originated from the central nucleus and developed the reaction. If interaction does operate to cause the angular momentum to be shared, which is the normal assumption, then the electron will not have the exact quantum $h/2\pi$.

The next problem with this system is that it will radiate electromagnetic waves because of the electron motion unless we can provide a photon unit to compensate. This is not feasible because such units are located in the E frame and the electron is moving in the inertial frame, in the strictly relative sense. Therefore, the only answer to turn to is that the electron is moving at an angular frequency exactly equal to the universal angular frequency Ω. Then there should be no radiation problem.

This then raises other problems. There is motion relative to the E frame. This means that there are magnetic effects to consider. Curiously, however, it is possible for us to analyse the system without considering the magnetic force between the charges. There is, instead, a radiated wave of *angular field momentum*. This has its reaction in the system and this will be analysed. The proposition is that the electron retains its quantum angular momentum $h/2\pi$ and that exactly the angular momentum needed by the nucleus is that in balance with the field angular momentum radiated. There is a mass-dependence in the analysis. This condition is only met for a definite nuclear mass quantity. It is this quantity which leads us to the mass of the H particle, and Nature happens to make this quantity just a little less than the energy quantum of 1,874 m available for its creation.

In Fig. 7.6 a charge e carried by a particle of mass M is depicted in a dynamically balanced state with an electron of charge $-e$ and mass m. The motion of the electron in the inertial frame is circular and has velocity v in an orbit of radius x. From the above introduction:

$$mvx = h/2\pi \tag{7.1}$$

The angular momentum of the particle of mass M will, therefore, be m/M times $h/2\pi$, from simple dynamic considerations. It is to be noted that Newtonian dynamics are deemed to be strictly applicable because we are not dealing with a translational motion through the electromagnetic reference frame. There is the cyclic motion at the

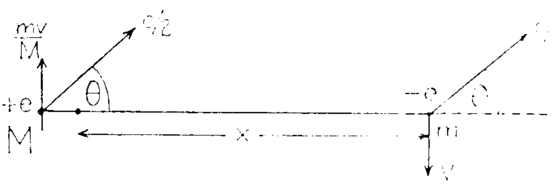

Fig. 7.6

frequency of space–time to consider. In fact, in some direction, say at angle θ to the line joining M and m, we must add the velocity vector $c/2$ to relate the motion in the inertial frame with one relative to the electromagnetic frame. The angle θ does not change during the successive cycles of the E frame since the motion of the E frame and that of the dynamic system under study are both at the angular velocity Ω. Note that the nature of the forces holding the two charges in this mutual orbital condition are not to be discussed. One must presume some kind of electric field interaction with space–time as we did in considering the physical basis of the Schrödinger Equation. There is some distinct similarity because the orbital radius can be shown to be $2r$ from the data just presented and this is the same radius as that of the orbit of the non-transit electron discussed in developing the explanation of wave mechanics.

It is shown in Appendix II that where there are two interacting current vectors in the same plane there must be a radiated field angular momentum equal to the product of the two vectors multiplied by:

$$\frac{1}{c}\left(\frac{\pi}{12}-\frac{1}{9}\right)\sin\theta_o \tag{7.2}$$

where θ_o is the angle between the vectors. The two current vectors have, of course, to be developed by separate charges. Since a current vector is charge times velocity divided by c, the quantity of interest from Fig. 7.6 is:

$$-\left(\frac{\pi}{12}-\frac{1}{9}\right)\frac{e^2}{c^3}\left(1+\frac{m}{M}\right)\frac{vc}{2}\sin\left(\theta+\frac{\pi}{2}\right) \tag{7.3}$$

Note that v is the velocity of the electron and that the field angular momentum has two components because there are two pairs of interacting current vectors.

For maximum angular momentum reaction consistent with a minimum energy deployment to form the mass M, the angle θ must be zero. This gives the total field angular momentum as:

$$-\left(\frac{\pi}{12}-\frac{1}{9}\right)\left(1+\frac{m}{M}\right)\frac{e^2v}{2c^2} \qquad (7.4)$$

On the principles introduced this quantity should compensate the angular momentum of M itself. That is, it should balance $(m/M)h/2\pi$. Since v/x is Ω or $c/2r$, (4.1) and (7.1) show that v is, simply, c. Thus, putting this in (7.4) and balancing with the angular momentum of M, we have a relation which can be rearranged as:

$$\frac{M}{m}=\frac{hc}{2\pi e^2}\,\frac{2}{\left(\frac{\pi}{12}-\frac{1}{9}\right)}-1 \qquad (7.5)$$

Upon evaluation, simplified by the fact that $2\pi e^2/hc$ is the dimensionless fine structure constant (approximately 1/137), we find that M/m is 1,817·8.

Later in this chapter it will be shown that particles having this mass of 1,817·8 m have an important role to play in the nuclei of heavy atoms. Such particles, being of extremely small radius, can readily combine with other particles, mesons, electrons, positrons, etc. For the moment, our interest must turn to the event in which an electron-positron pair, developed as the particle is actually formed, participates in the angular momentum reaction in the field. The proton is the prime system under study, so we will analyse the system presented in Fig. 7.7.

In Fig. 7.7 an electron-positron pair is shown to be in the near

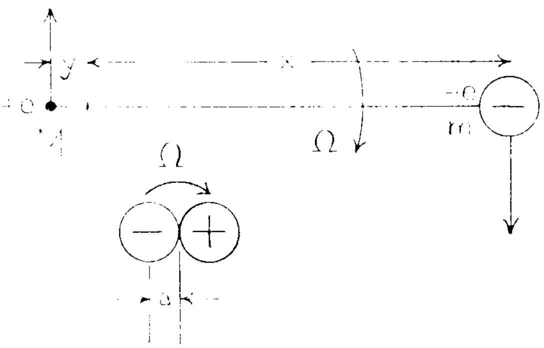

Fig. 7.7

vicinity of the heavy particle and the electron. This heavy particle, termed the H particle, moves in balance with the electron as described already by reference to Fig. 7.6. The electron-positron pair forms its own dynamic balance system and also rotates about its own centre of inertia at the angular frequency Ω. These motions are about parallel axes and are synchronous in the sense that the velocity vectors of the particles in the two systems are at all times mutually parallel or anti-parallel, but in such relative direction as to assure the maximum combined angular momentum reaction in the field.

The purpose of this analysis is really to determine the mass of the heavy particle formed in the event of its creation being in close association with an electron-positron pair. The previous analysis led us to the mass of such a particle when created in isolation. Also, before proceeding too far, it is as well to realize that later we will be confronted with the problem of how, once the heavy particle is formed, it ever gets into the E frame to become normal matter. It will need angular momentum then in much larger quantities than can be induced by reaction with the field radiation. This problem will be discussed in Chapter 9.

Now, referring to Fig. 7.7, it is necessary to calculate the angular momentum of the field radiation due to the mutual interaction of the four particles. Any particle will react with the compounded $c/2$ current vectors of the other three. The result is four terms in the angular momentum expression:

$$-\left(\frac{\pi}{12}-\frac{1}{9}\right)(y-a-a+x)\left(\frac{c}{2}\right)\frac{\Omega e^2}{c^3} \tag{7.6}$$

It is noted that the paired electron has a radius a, and therefore a velocity vector $-a\Omega$, whereas the positron has a velocity vector $a\Omega$. Since they have opposite polarity charge they combine to provide unidirectional current vectors.

As before, the value of x is $2r$, and y is $(m/M)2r$, where M is now the mass of the H particle. From (6.60), (6.69) and (6.70), the electron radius a is $4/3(ar)$, or $r/103$. Ω is $c/2r$. Thus (7.6) is simply:

$$-\left(\frac{\pi}{12}-\frac{1}{9}\right)\left(1+\frac{m}{M}-\frac{1}{103}\right)\frac{e^2}{2c} \tag{7.7}$$

As before, we equate this in magnitude to $(m/M)h/2\pi$ and find that M/m is 103/102 times the value given by (7.5). It is thus deduced that M is 1,835·6 m. The mass of the H particle we seek is about 0·25 m

less than the mass of the proton. The mass of the proton is about 1,836·2 m, so the H particle mass should be about 1,835·9 m, say. This is near enough to exact agreement with the theoretical value, so it can be said that very probably this analysis is well founded. The mass of the H particle has been derived from fundamental principles and it has been shown that there are two such heavy particle forms. They both are likely to have positive charge e. The heaviest is formed in close association with an electron-positron pair and has a mass a little less than 1,836 m. The lightest is formed in isolation and has a mass of about 1,818 m. This happens in the presence of an available energy quantum of about 1,874 m released from the graviton, which, possibly, provides the nucleus for the formation of these heavy particles. As might be expected, the electron-positron pair can join with the H particle once formed to create the proton form B, already deduced as being the most prevalent in the process of matter creation.

Atomic Nuclei

Before studying the spin properties of the proton, neutron and deuteron and providing further verification of the theoretical approach so far followed, it is convenient to pause here to explain the nature of the binding forces in heavier atomic nuclei.

The atomic nucleus comprises an aggregation of elementary particles. Principally, the nucleus is composed of protons and neutrons. We believe this because all atomic nuclei have masses which increment by approximately the same amount relative to their neighbours in the atomic mass scale. This mass increment is approximately the mass of the neutron or proton. Mass incrementation by the addition of a proton increases the electric charge of the nucleus by the unit e. It follows that if a nucleus has charge Ze it is most likely composed of Z protons. If its atomic mass is approximately X times that of the proton (after adding a little to account for binding energy) it is most likely composed also of $X-Z$ neutrons.

Our problem is to determine how the mutually repulsive charges are held together and to examine what other elementary particles are in the nuclear composition. This problem is readily answered by this theory and is supported by the appropriate quantitative and qualitative findings.

The analysis of the deuteron has shown how nuclei might be formed from elementary particles. There is, however, a problem in suggesting that heavy nucleons can become closely compacted. This is the problem of gravitational balance. It was shown in Chapter 6 that the gravitons in the G frame provide the gravitational mass balance in space–time. These particles have a mass which is about 2·7 times that of the proton. Further, these gravitons, being mutually repulsive, cannot compact without losing their space–time character. The statistical probability of the proximity of a graviton to any element of matter is related to the mass of that element so that the balance condition is assured. The gravitons are effectively melded with the distributed charge of the continuum element of space–time. They have a distribution which makes the mass density of this continuum G frame system uniform save where mass of matter present requires some concentration. The gravitons are, therefore, spaced apart on some statistical basis. However, the closest spacing where balance is needed within a well-compacted atomic nucleus is deemed to be the metric spacing d, the spacing of the lattice forming space–time. This will be discussed further in Chapter 9, since it involves possibilities which are a little speculative but, suffice it to say, we will assume that the proper spacing of gravitons in a nucleus has a lattice form with spacing d. The gravitons can move about in their statistical pattern but favour certain relatively spaced discrete positions matching the spacing of the space–time system. On this basis, we will also preclude more than two heavy nucleons from forming a compacted nucleus. The gravitons cannot balance three nucleons in a closely compact state. Further, in atomic nuclei containing more than two heavy nucleons, it seems more logical for them to have the regular spacing introduced above. In short, our hypothesis is that a loosely compacted nucleus can be formed of many nucleons provided it has a dynamic affinity with a graviton spacing matching the lattice spacing of the particles forming the E frame of space–time. This allows the nucleons to occur singly (or perhaps in pairs as well) in an atomic nuclear lattice also of cubic form and of spacing d of $6{\cdot}37\ 10^{-11}$ cm.

We may then portray an atomic nucleus as in Fig. 7.8, where the bonds between the nucleons are all of length d and are aligned with the fixed directions of the space–time lattice. This means that an atomic nucleus lattice cannot spin, even though the individual nucleons may spin about their own diameters and the whole nucleus can move linearly or in an orbit relative to the E frame lattice. The nucleus lattice retains its fixed spatial orientation.

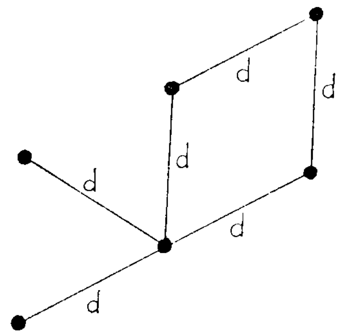

Fig. 7.8

Nuclear Bonds

What is the form of the nuclear bonds? Each of the six nucleons in Fig. 7.8, three protons, say, and three neutrons, identified by the full bodied circles, has a bond of its own providing one of the links. These bonds are the real mystery of the atomic nucleus. We will assume that their most logical form is merely a chain of electrons and positrons arranged alternately in a straight line. The reason for the assumption is that electron-positron pairs are readily formed in conjunction with matter, and we have seen how an in-line configuration of alternate positive and negative particles has proved so helpful in understanding the deuteron. Stability has to be explained. Firstly, the chain is held together by the mutually attractive forces between touching electrons and positrons. Secondly, it will be stable if the ends of the chain are held in fixed relationship. This is assured by the location of the nucleons which these bonds interconnect. In Fig. 7.9 it is shown how the bonds connect with the basic particles. In the examples shown, the nucleons are positioned with a chain on either side and are deemed to be spinning about the axis of the chain. Intrinsic spin of the chain elements will not be considered. It cancels as far as observation is concerned because each electron in the chain is balanced by a positron. In Fig. 7.10 it is shown how, for the neutron, for example, the spin can be in a direction different from that of the chain. Also, it is shown how another chain may couple at right angles with this one including the neutron. Note, that the end electron or positron of the chain does not need to link exactly with the nucleon. Therefore, it need not interfere with the spin.

We will now calculate the energy of a chain of electrons and positrons. For the purpose of the analysis we will define a standard

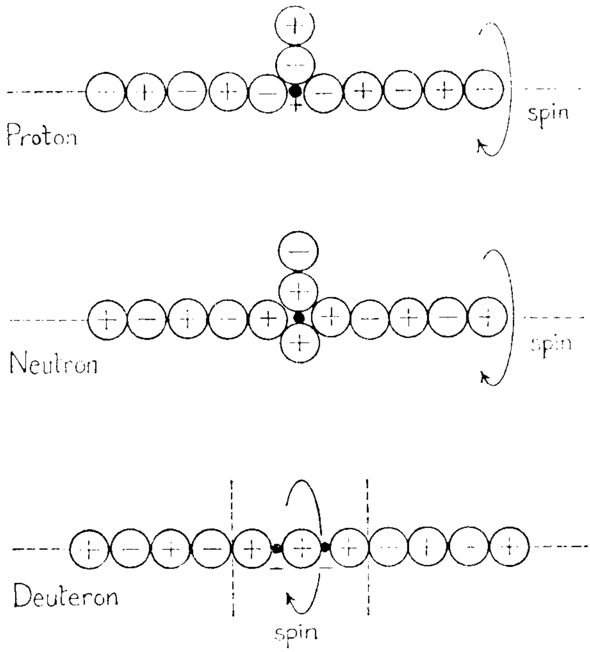

Fig. 7.9

energy unit as $e^2/2a$. This is the conventional electrostatic energy of interaction between two electric charges e of radius a and in contact. Since $2e^2/3a$ is mc^2, as applied to the electron, this energy unit is $0{\cdot}75\ mc^2$. On this basis, a chain of two particles has a binding energy of -1 unit. If there are three particles the binding energy is the sum of -1, $\frac{1}{2}$ and -1, since the two outermost particles are of opposite polarity and their centres are at a spacing of $4a$ and not $2a$.

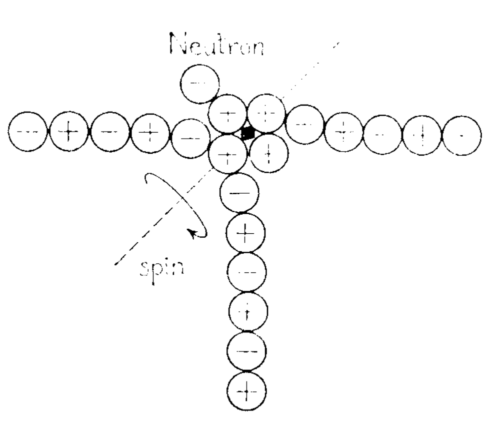

Fig. 7.10

For N particles, with N even, the total interaction energy is:

$$-(N-1)+\frac{(N-2)}{2}-\frac{(N-3)}{3}+\ldots\frac{2}{(N-2)}-\frac{1}{(N-1)}$$

which is $-N \log 2$, if N is large. If N is odd, the last term in the above series is positive and the summation, for N large, is $1-N \log 2$. To find N we need to know how many particles are needed for the chain to span a distance d. d can be related to m by eliminating r from (4.1) and (6.60). Then $d/2a$ is found using $2e^2/3a=mc^2$. It is 54π, so N may be, say, 169, 170 or possibly 168, particularly if N has to be even and there has to be space for any nucleons. For our analysis we will calculate the binding energy of the chain and the actual total energy of the chain for all three of these values of N. The data are summarized in the following table.

N	168	169	170
$-N \log 2$	−116·45	−117·14	−117·83
Binding Energy (units)	−116·45	−116·14	−117·83
Binding Energy (mc^2)	−87·34	−87·11	−88·38
Add Self Energy (mc^2)	168	169	170
Total Chain Energy	80·66	81·89	81·62
Ground State Correction	0·61	0·62	0·62
Corrected Energy (mc^2)	81·27	82·51	82·24

In the above table the binding energy has been set against the self energy of the basic particles and a correction has been applied of amc^2 per pair of particles to adjust for the fact that mass is not referenced on separation to infinity, as was discussed earlier in this chapter. The total mass energy of the chain is seen to be about 81 or 82 electron mass energy units, depending upon its exact length.

This shows that while the electron-positron chain proposed will provide a real bond between nucleons linked together to form an atomic nucleus, it will nevertheless add a mass of some 81 m per nucleon. This seems far too high to apply to the measured binding energies. Furthermore, it is positive and the nature of binding energy is that it must be negative. This can be explained by introducing the π meson or pion, as it is otherwise termed.

The Pion

When an electron becomes attached to a small but heavy particle of charge e, the interaction energy is very nearly $-e^2/a$ or 1·5 times the energy unit mc^2. This means that the mass of the heavy particle is effectively *reduced* when an electron attaches itself to it and becomes integral with it. If we go further and seek to find the smallest particle which can attach itself to a heavy nucleon to provide enough surplus energy to form one of the above-mentioned electron-positron chains, we can see how this nucleon plus this particle plus this chain can have an aggregate mass little different from that of the initial nucleon. This can reconcile our difficulties. The fact that an electron can release the equivalent of about half its own mass indicates that to form the chain of mass 81 m we will need a meson-sized particle of the order of mass of the muon or pion. To calculate the exact requirement we restate the inverse relationship between the mass m of a particle of charge e and its radius a:

$$2e^2/3a = mc^2 \tag{7.8}$$

This applies to the electron, but it can also be used for other particles such as the meson and the H particle.

It may then be shown that if two particles of opposite polarity charge e are in contact, their binding energy, e^2 divided by the sum of their radii, is $3c^2/2$ times the product of their masses divided by the sum of their masses. Let M_o be the mass of the meson involved and M be the mass of the H particle. The following table then shows the value of the surplus energy:

$$\frac{3M_oMc^2}{2(M_o+M)} - M_oc^2 \tag{7.9}$$

in terms of units of mc^2, for different values of M_o/m and the two values of M of 1,818 m and 1,836 m.

M_o/m	$M = 1{,}818\ m$	$M = 1{,}836\ m$
230	76·1	76·4
240	78·0	78·3
250	79·7	80·0
260	81·2	81·5
270	82·6	83·0
280	84·0	84·5

This shows that the energy of the formation of the meson will be adequate to form the chain if the meson is in the mass range of M_o/m between 260 and 270. The only meson available in this range is the neutral π meson of mass $264{\cdot}6 \pm 3{\cdot}2\ m$, according to Marshak (1952). However, this is a neutral meson. The best available meson, that is the one of lowest mass and having a charge but yet sufficient to form a chain of energy 82 mc^2, is the charged π meson which has a measured mass of about 276 m. According to the above table, this affords an energy of slightly less than 84 mc^2, which is sufficient to form a chain while providing a surplus of one or two electron mass units. This means that the combination of such a meson, a nucleon and a chain has a total mass which differs from that of the nucleon itself by only one or two electron mass units. The total mass will be less by this amount so that this really is a measure of the binding energy involved.

This gives us an approach to calculating the mass of an atomic nucleus. The nucleus can be regarded as an aggregation of some protons containing H particles of mass 1,818 m or 1,836 m or a mixture of both, some neutrons which may also comprise either H particle, and as many π mesons and chains as there are nucleons (except for the deuteron and the hydrogen nucleus). There is the clear indication that the π meson has an important role to play in nuclear physics. In fact, it has been believed for some years that it is involved in the binding mechanism of the atomic nucleus, and this theoretical finding is, therefore, by no means unexpected.

It is of interest to speculate about the electron-positron chain coming free from the nucleus. With an even value of N the chain would be a neutral entity having a mass of 81·27 or 82·24 times that of the electron. If this latter energy is deployed to remove a meson attached to an H particle of mass 1,836 m, the above table shows that it could develop a meson of mass 265 m. If the meson came from the lighter H particle, it would be 267 m. It is possible, therefore, that the nuclear chain could be created by the formation of a charged π meson of mass 276 m, as the latter comes into aggregation with the H particle. Energy of some one or two electron mass units is surplus from this reaction. However, in the reverse direction, it might happen that the π meson can, in nuclear reactions, expand to lose some of its energy and, then, just as it reaches the stage where a chain can collapse to provide the energy needed to drive the meson away from the H particle, it is released. At this stage its mass would be about

265 m or 267 m. Although it would still have a charge, it could be that this process has some relation with the formation of the neutral π mesons. These do have this lower mass value.

This is, of course, mere speculation. It is open to criticism because it is not clear how a long series of electrons and positrons can just vanish and release all their mass energy. If they meld into space-time, as with the annihilation of the electron-positron pairs, there is still about 3% of the energy of mc^2 of each electron and positron needed to sustain the charge in its new form (see page 138). Thus, about $5mc^2$ is to be subtracted from the energy released by the chain. Also, if we examine Fig. 7.9 closely and ask how a meson is attached to the heavy H particle in each of the systems shown, we see that it is easy in the case of the proton but in the case of the neutron or deuteron an oppositely-charged particle would make it difficult to have the particle configuration shown. Even in the case of the proton, the presence of a negative meson attached to the positive H particle opposite the electron-positron pair, would alter the polarity sequence of the chain ends.

These are not problems which invalidate the theory. They are indications that we cannot expect to have the atomic structure fit together easily to provide simple and convincing results. It is possible that we should not be thinking in terms of protons and neutrons when we analyse heavy atoms. Perhaps we should consider only H particles connected by chains and having the mesons attached to them, possibly in the chain. The answers can probably best be found by indirect analysis. For example, the spin properties of the proton and neutron can be studied under different conditions. This type of approach seems more appropriate at the present stage of development of the theory.

Proton Spin

The nuclear theory presented so far in this chapter might seem to be elaborate in certain respects. However, it has been supported by the following quantitative results:

(a) The derivation of the observed binding energy of the deuteron,
(b) The derivation of the observed energy of the electron ejected in neutron to proton decay,
(c) The derivation of the observed mass of the π meson, in the

approximate sense and on the assumption that the π meson serves a prime role in nuclear binding,

(d) The derivation of the mass of the H particle from first principles, this quantity being then available to obtain from this theory the masses of the neutron, proton and deuteron, all stated as a ratio in terms of the mass of the electron.

The question now faced is whether these same principles guide us to the magnetic moments and spin angular momenta of these nuclear particles.

Consider the spin condition of the proton shown in Fig. 7.11. The spin condition is deemed to be that in which a particle rotates about a centre within the particle. Thus a single sphere of charge rotating about a diameter is said to *spin*. An aggregation of such charge spheres rotating about the common centre of mass can be said to spin also. *Intrinsic spin* will be used to represent the sum of the spins of the individual spheres of charge in such a particle aggregation. Thus, in Fig. 7.11 we denote the spin angular velocity about the

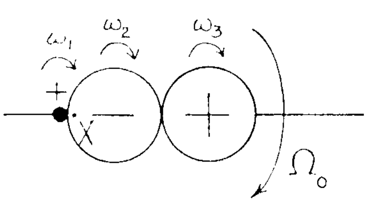

Fig. 7.11

point X as Ω_0. X is the centre of mass of the proton and is distant approximately two H particle radii from the centre of the H particle. The particles in the proton are deemed to be in rolling contact. Let $\omega_1, \omega_2, \omega_3$ denote the angular velocities of the H particle, the electron and the positron in the inertial frame. Then, relative to the line of centres which rotates at Ω_0, the angular velocities become $\omega_1 - \Omega_0$, $\omega_2 - \Omega_0$, $\omega_3 - \Omega_0$ respectively. For rolling contact, taking radii as r_1, r_2, r_3 respectively:

$$(\omega_1 - \Omega_0)r_1 = -(\omega_2 - \Omega_0)r_2 = (\omega_3 - \Omega_0)r_3 \tag{7.10}$$

The spin angular momentum of each component particle is proportional to its mass, angular velocity and radius squared. Since mass is inversely proportional to radius, spin angular momentum is proportional to $\omega_1 r_1, \omega_2 r_2, \omega_3 r_3$ for the three particles respectively. The intrinsic spin angular momentum of the proton is thus proportional to the sum of these quantities. This spin angular momentum is assumed to be zero, as will be discussed later. Accordingly:

$$\omega_1 r_1 + \omega_2 r_2 + \omega_3 r_3 = 0 \tag{7.11}$$

Now, r_2 and r_3 are respectively the radius of the electron and positron, both denoted a elsewhere in this book. r_1 is the radius of the H particle and is $(m/M)a$, where m/M is the mass ratio of the electron and H particle. Since M is about 1,836 m, r_1 can be assumed negligible for a first analysis, making ω_1 very high and allowing $(\omega_1 - \Omega_o)r_1$ in (7.10) to be replaced by $\omega_1 r_1$. From (7.10) and (7.11) it is then simple algebra to show that ω_1, ω_2, ω_3 are respectively $-2\Omega_o(M/m)$, $3\Omega_o$, $-\Omega_o$.

We can now consider the magnetic moment of the proton. From Appendix I the spin contribution of each component particle is $e/6c$ times angular velocity and radius squared. For orbital motion $e/6c$ has to be replaced by $e/2c$, as is well known. Also, it must be remembered from Chapter 2 that, strictly, these quantities may have to be increased by a factor to explain certain anomalous behaviour.

The spin contribution just mentioned is one-third that of the related orbital contribution simply because the charge within the sphere is distributed over its volume. Accordingly it cannot be regarded as all being at the specified radius, as it can in the case of orbital motion. In evaluating the spin magnetic moment of the composite particle shown in Fig. 7.11, we find that there is a component due to the intrinsic spin and a component due to the spin about the point X. This latter component is evaluated from the above mentioned orbital formulation. Thus, it consists approximately of only two major elements, $e/2c$ times $9a^2\Omega_o$ for the positron and $-e/2c$ times $a^2\Omega_o$ for the electron. Note that $r_2 + 2r_3$ is $3a$. The H particle makes a very small contribution to magnetic moment and it can be ignored. Due to intrinsic spin, there are also two major elements, $e/6c$ times $a^2\omega_3$ for the positron and $-e/6c$ times $a^2\omega_2$ for the electron. Again, the H particle can be ignored. Since ω_2 is $3\Omega_o$ and ω_3 is $-\Omega_o$ the total contribution due to intrinsic spin is $-4(e/6c)a^2\Omega_o$. Collecting the components due to motion about X gives $8(e/2c)a^2\Omega_o$. Thus the total magnetic moment should be $20(e/6c)a^2\Omega_o$ times the appropriate anomalous factor. Putting this as γ we have a proton magnetic moment of:

$$20\gamma(e/6c)a^2\Omega_o \tag{7.12}$$

In connection with Fig. 4.4 it was explained how the nucleus of an atom has an angular momentum exchange relationship with a nuclear photon unit. Applying this to the proton, it is to be expected that the rotation about the point X will be synchronous with the rotation of the photon unit. The reason is that the proton has a non-symmetrical distribution of its charge. A small electric disturbance developed by the rotation of the proton can probably be compensated by an appropriate but very small perturbation of the motion of the associated electron. This tells us that:

$$\Omega_0 = 4(\omega_0 - \omega) \tag{7.13}$$

where ω now has the meaning given in Fig. 4.4. The sense of "synchronous", as just used, therefore means that the rotation frequency of the proton about its centre of mass is exactly *four* times that of the photon unit. The reason is that the photon unit generates four pulsations every revolution. For the standard photon unit, ω_0 is $\Omega/4$ and $I\omega_0$ is $h/2\pi$. For the simple electron-proton system, (4.21) shows that $I\omega$ is $ah/2\pi$. This shows that (7.13) becomes:

$$\Omega_0 = (1 - a)\Omega \tag{7.14}$$

The magnetic moment of the proton is evaluated from (7.12) and (7.14). To test this analysis it has to be noted that the measured magnetic moment involves a pre-knowledge of the proton spin angular momentum. This angular momentum is finite, even though we have assumed a total intrinsic spin component to be zero. There is a basic angular momentum quantum of $h/4\pi$. In interpreting proton magnetic moment measurements this quantum is assumed to apply. However, remembering the mechanism presented in Fig. 4.4, we have to note that an angular momentum ε is transferred between the electron and the proton. This quantity ε is $I\omega$ in (4.21). Thus, it is to be expected that the proton angular momentum is really $(1+2a)h/4\pi$ and the electron angular momentum $(1-2a)h/4\pi$ in this particular system. The magnetic moment of the proton is measured by a resonance technique in which the ratio of the *actual* magnetic moment and the *actual* angular momentum is observed. If the angular momentum has been underestimated then the measured magnetic moment will be too high. To facilitate comparison with reported measurements based upon the assumed half-spin quantum, the proton magnetic moment given by (7.12) and (7.14) should be adjusted by multiplying it by $(1+2a)$. Thus, the proton magnetic moment can be written as:

$$20\gamma(e/6c)a^2(1-a)(1+2a)\Omega \qquad (7.15)$$

At this stage, we pause to introduce a result derived in Appendix III. The value of γ is 9·6, a quantity much higher than the factor of 2 derived for the large-scale orbital motions in Chapter 2. It seems that in order to generate the kinetic reaction effects in the field medium the spins of elementary particles have to be higher than one would expect from normal theory. This result is deduced from the analysis of the balance conditions of magnetic field and angular momentum in the space–time system. It can be put to immediate test in applying (7.15).

Putting γ as 9·6 in (7.15) and noting that a/r is $4a/3$, Ω is $c/2r$ and a is 1/137, the expression for the measured proton magnetic moment becomes:

$$\frac{256}{9}a^2(1-a)(1+2a)er$$

where er is the Bohr Magneton. When evaluated this gives:

$$1{\cdot}525\ 10^{-3}$$

Bohr Magnetons, which is very close to the measured value of $1{\cdot}521\ 10^{-3}$. The fact that the H particle has been taken to be of negligible size may account for the slight difference in these results. Certainly, it seems that there is evidence to support the proton form presented, besides affording verification of the theoretical evaluation of γ.

Neutron Spin

To calculate the spin properties of the neutron we have to know the form assumed by the neutron in the experimental environment of nuclear resonance. If another electron is added to the proton system in Fig. 7.11 on the left-hand side of the H particle and the proton spins are retained, we can easily calculate the neutron magnetic moment. In the case of the proton magnetic moment the electron contributed -6 units to the parameter 20. Thus, for the neutron just developed the parameter 20 in (7.12) becomes 14. The ratio of the neutron magnetic moment to that of the proton should therefore be about 14/20 or 0·7. In fact, from experiment it is $-0{\cdot}6850$. The minus sign means that we should have inverted all the polarities in the neutron model just proposed. It must comprise a negative H particle, two positrons and one electron. It has the form used in Fig. 7.4 and as depicted as form B in Fig. 7.1.

It is possible that when the ratio of the magnetic moments of the proton and neutron is measured they are so close together that the proton is not bound by the photon unit coupled with the electron action but the neutron is. The neutron does not really qualify for pairing with an electron, and thereby being detected, since it has no resultant charge. However, it can assert an association with an electron if it is paired with a proton and if it takes over the electron associated with the proton. The affinity between the neutron and the electron may be favoured from their magnetic interaction. This means that the proton will have the half spin quantum $h/4\pi$ whereas the neutron will take the angular momentum $(1+2a)h/4\pi$ and rotate with a photon unit to comply with (7.14). We then expect the measured ratio of neutron and proton magnetic moments to be $-0{\cdot}7$ times $(1-a)/(1+2a)$ or $-0{\cdot}6849$. This seems close enough to the measured value of $-0{\cdot}6850$ to give adequate satisfaction. It is further gratifying because in evaluating a ratio we avoid dependence upon the parameter γ.

We now turn attention to Figs. 7.9 and 7.10. The neutron is there shown in its bound state in the atomic nucleus coupled to the electron-positron chains by attachment to the positron terminations of the chains. These illustrations were merely diagrammatic. The coupling needs to be considered more closely. In Fig. 7.12 an electron and a positron are shown attached to the neutron along the spin axis. They are ready to form the connections with any chains in the nucleus. It may be shown that a pair of electrons or a pair of positrons cannot

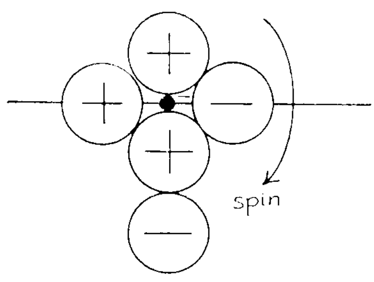

Fig. 7.12

replace the added electron-positron pair and yet form an arrangement in which the forces between the component particles will hold things together. We must assume, therefore, that a neutron can capture an electron-positron pair to form the system shown in Fig. 7.12 or, at least, that it joins to nuclear bonds through an electron on one side and a positron on the other. If the neutron spins there will be rolling contact with these end particles. For no slip they must rotate and so become a feature of the neutron spin. This is the other reason why they should have opposite polarity. Their magnetic moments will cancel and so not affect the above analysis.

Neglecting the finite size of the H particle, and remembering that the adjacent particles have spin at $3\Omega_0$ besides rotating about the neutron spin axis at Ω_0, we see that the contact with the end particles causes them to spin on the neutron spin axis at $-2\Omega_0$. The point about this is that for electrons or positrons on a spin axis an angular velocity of $2\Omega_0$ is to be expected.

Deuteron Spin

The deuteron has symmetry and is therefore not involved in a spin governed by photon units. The problem, therefore, is to decide how to determine any spin of the three positron constituents in its composition. From the foregoing comments one could guess that each positron may have a spin of $2\Omega_0$ where Ω_0 is put equal to Ω. The parameter of magnetic moment is then 6 units compared with 20 for the proton and -14 for the neutron. Alternatively, since the deuteron is little different from a proton and a neutron combined we can possibly combine 20 and -14 to obtain the same parameter 6.

To apply this to experiment we note that in terms of a measured separate proton resonance for which the proton magnetic moment parameter is slightly less than 20 and its spin angular momentum slightly more than $h/4\pi$, the deuteron magnetic moment is:

$$\frac{6}{20}(1+2a)/(1-a) \tag{7.16}$$

Upon evaluation, this is 0·3066, which compares with a measured value of 0·3070. Again, allowing for the fact that the dimensions of the H particle are ignored, this result is excellent.

The difficulty with the deuteron is to understand how it contributes to the magnetic resonance experiment. Are we even certain that the deuteron which performs in such experiments is quite the same as the one which undergoes transmutation in nuclear processes? May it not be that a proton and a neutron have become locked together in a state of spin? Going back to the basic deuteron model, let us examine what has to happen to a neutron and a proton for the compacted deuteron to form. In Fig. 7.13 the neutron and the proton are shown

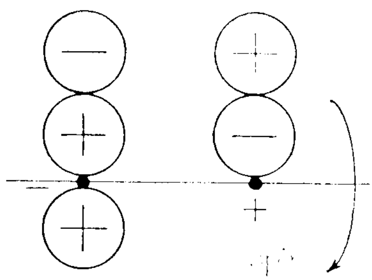

Fig. 7.13

side by side spinning about the same axis. Note that the spin motions of the outer electron in the neutron and the outer positron in the proton are identical from the foregoing analysis. Since these two particles have opposite polarity they effectively cancel one another's magnetic moment. Now, if the neutron and the proton become locked together in a spin motion state, the combined magnetic moment is independent of the presence of the electron and positron just mentioned. If the neutron and proton fuse together and eject the electron and the positron we have the inverse process to that shown in Fig. 7.4. There, the deuteron absorbed an electron and a positron to form a neutron and a proton. Here, once the electron and positron are removed, we are left with the same total magnetic moment. Also, by the inversion of the positive H particle and its electron, we can expect aggregation to form the deuteron comprising two negative H particles and three positrons. If each positron adopts a 2Ω spin, or thereabouts, sharing the magnetic moment of the neutron and proton, the magnetic moment of the deuteron is still as given by (7.16) in comparison with that measured for the free proton. It follows that it is possible to explain spin magnetic properties of the deuteron in terms of the same model as was used to calculate the binding energy. This affords a double check on the nature of the deuteron and its constituent nucleons.

Electron Spin

Before leaving this chapter we must consider the rather complicated problem of electron spin.

In the analysis in Chapter 4 it was found appropriate to assume that the total angular momentum of a basic particle (the lattice particle or the electron) is zero. This meant that there was a spin component and an orbital component compensating each other, as formulated in equation (4.4). It will also be found in Appendix III that we will apply this concept of total angular momentum being zero for the lattice particle when we analyse the residual spin frequency of the particle. Quite apart from angular momentum balance, we will there use the particle spin to explain the source of a magnetic moment balancing the magnetic moment of the continuum charge in space–time. The latter moves cyclically relative to the electromagnetic reference frame set by the lattice particles. Now, the balance conditions just mentioned are subject to small residual effects. In the main these can be ignored in the analysis. However, to explain certain phenomena and discrepancies in quantitative analysis we do have to pay attention to them.

The anomalous spin properties of the electron *may* be due to this cause. For the orbital electron we have seen in Chapter 2 that an angular momentum of $h/2\pi$ can develop a magnetic effect equivalent to that of two Bohr Magnetons. The magneto-mechanical ratio is e/mc and this leads to a magnetic moment based on $h/2\pi$ of twice $eh/4\pi mc$, the Bohr Magneton. It was there shown that reaction effects cancelled half the field, thus making the *apparent* magnetic moment of an orbital electron of angular momentum $h/2\pi$ seem to be that of the Bohr Magneton. When we turn to the problem of spin we find evidence of half-spin quanta of angular momentum $h/4\pi$ and the measured magneto-mechanical ratio of the electron appears still to be e/mc, though only approximately. Indeed, the anomaly factor of 2 becomes, when measured, slightly higher than 2 by the factor $1{\cdot}001146 \pm 0{\cdot}000012$ or $1{\cdot}001165 \pm 0{\cdot}000011$. Sommerfield (1957) has presented the experimental data and mentions these two conflicting measurements. The anomalous component in this factor is assumed to be in the magnetic moment and not in the angular momentum. Also, Farley *et al.* (1966) have measured the same anomaly for the negative muon and found the anomalous component to be $0{\cdot}0011653 \pm 0{\cdot}0000024$.

There is, therefore, a fundamental problem to answer. It is associated with spin, and yet spin seems to be some property merely attributed to the half-quantum $h/4\pi$, whereas the main anomalous effect is associated with the mysterious doubling of the magneto-mechanical ratio. The anomalous properties of the electron may still be seated in what can just as well be termed orbital motion.

Quantum electrodynamics already provides an answer for the anomaly. By a rather complex treatment, which has not been wholly accepted by the physicist, quantum electrodynamics gives a value of $a/2\pi$ or 0·001161, subject to slight upward revision to allow for higher order terms in the calculations. As before, a is the fine structure constant. It is therefore not really necessary to challenge this explanation in this work. Quantum theory is linked to the concepts newly introduced in the previous pages. Thus the anomalous magnetic moment of the electron and the not-unrelated phenomenon known as the Lamb Shift which already have explanation in physics need not strictly be pursued here. However, the author has relied upon the space–time reaction as offering explanation for the anomalous factor of 2 in electron magneto-mechanical studies. Also, the quantum electrodynamic explanation presents some doubts. Therefore, the reader may be interested in a little speculative enquiry into the anomalous electron spin properties.

In the analysis of the formation of the H particle it was found that some field angular momentum due to radiation would be developed. Thus, there can be change in angular momentum according to the different states of transmutation of the system of particles involved. A basic angular momentum quantum due to field radiation is that given by (7.4). Ignoring the small component m/M and introducing the value of r, this expression gives the angular momentum quantum:

$$\left(\frac{\pi}{12}-\frac{1}{9}\right)\frac{e^2}{2c} \tag{7.17}$$

This angular momentum quantum has some association with the existence of the H particle. Now, consider an H particle and an electron as shown in Fig. 7.14 spinning in rolling contact and turning at the universal angular velocity Ω about their common centre of mass. Neglecting terms in m/M, the mass ratio of the electron and H particle, the angular momentum of the system is $ma^2\Omega$ or $\frac{1}{2}mcr(a/r)^2$, which is $\frac{1}{2}(h/4\pi)(4a/3)^2$.

We thus have, as it were, a need for these small angular momentum

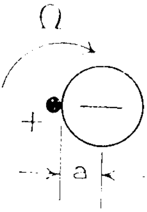

Fig. 7.14

quantities when we think of the transmutation of particles involving heavy nucleons, the H particles, in motion at the angular velocity Ω. The motion states considered involve balance with an electron. Consequently, it may be that these angular momenta have some residual association with the electron even when it has transferred to perform other roles. Guided by the quantitative implications, we will evaluate the two angular momentum quantities just derived. That just presented is simply 8/9 divided by 137 squared in units of $h/4\pi$. This is:

$$0{\cdot}000049$$

(7.17) is simply evaluated since $e^2/2c$ is $a(h/4\pi)$. It is:

$$0{\cdot}001100$$

Together, the angular momenta total 0·001149 half-spin units which could possibly be an anomalous angular momentum component of the electron. Furthermore, as already discussed, the electron participating in balance in magnetic nuclear resonance measurements can have an angular momentum of $(1-2a)h/4\pi$ owing to transfer action with the nucleus. This is mentioned in deriving (7.15). On this basis it is possible that in some situations the anomalous parameter 0·001149 is referenced on $1-2a$ instead of unity. This would increase its effect, as a ratio, to 0·001166.

This is mere speculation. No attempt is made to explain the physical processes by which the electron acquires its residual spin properties. Further, no attempt is made to explain the true nature of the magnetic moment of the electron. There are problems remaining. Suffice it to say that we need not be surprised that the electron behaves anomalously. It may be coincidence that the analysis just presented leads to anomalous factors of 0·001149 and 0·001166 according to the two possible states of the electron in its nuclear balance role. The fact that two conflicting measurements of 0·001146 and 0·001165 have emerged in practice is certainly of interest. Although, as yet, the argument presented is not conclusive, it is possibly sufficient to show the reader that the success of the quantum electrodynamic approach may not be the last word on the subject. What is offered here may lead to a better explanation.

The outcome of this review is that residual spin properties are a feature of the electron produced in transmutations. Apart from this, the zero total angular momentum condition is retained and can be applied both to the space–time lattice particles and, at least to close approximation, to the electron moving with the *E* frame. The half-spin quantum $h/4\pi$ remains standard either as the basic approximate quantum of electron spin or as the balancing orbital effect due to *E* frame motion and *G* frame balance. The proton in the *E* frame has zero intrinsic spin. Other heavy composite particles, the neutron and the deuteron, for example, appear to have a small intrinsic spin. Thus, it appears that, apart from any intrinsic spin, heavy particles containing nucleons have a total spin property not merely set by their mass and not merely in balance with the *E* and *G* frame motion components. These particles somehow get primed with spin angular momentum in multiples of $h/4\pi$. The proton has a spin angular momentum of $h/4\pi$ in spite of its zero intrinsic spin. The neutron has the same spin angular momentum with non-zero intrinsic spin. The deuteron has a spin angular momentum of $h/2\pi$. This topic will be discussed further in Chapter 9. The quantum nature of the spins of heavy particles has been assumed in the above analysis of spin magnetic moments. There were minor modifications of the spin quantization to allow for transfers of angular momentum. These involved the fine structure constant α. Accordingly, though it is claimed that an adequate account of magnetic moment of the spin states of nuclear particles has been developed, there is no explanation given for the angular momentum quantization. Also, the heavy particles containing nucleons do have angular momentum from their motion with all matter in the *E* frame. It is not true to say that their angular momentum sums to zero. Thus an out-of-balance of the angular momentum is a feature of the presence of matter in space–time. It is not surprising, therefore, to find astronomical bodies turning without there being any apparent balance of angular momentum amongst matter.

The problem of the spin magnetic moment of the electron has not been analysed directly. It will be shown in Appendix III that a lattice particle develops, by spin, a magnetic moment equal to two Bohr Magnetons. Perhaps the electron does the same for the same reason when it is set in the *E* frame. Perhaps, however, since this magnetic moment is locked in a fixed direction in space and is acting to cancel that developed by other electric charge in space–time, this property passes undetected. We do not need to speculate about it further. Little is likely to emerge. It is true that spin magnetic moment of the electron has been explained on established theory as being due to two separate components of charge differently distributed over the electron. One is deemed to rotate while the other remains at rest. This is bold assumption, indeed. It is analysed by Page and Adams (1965). It is demonstrative of the difficulties which the physicist has given himself by refusing to have anything to do with a real space–time medium and retaining inflexible electrodynamic principles.

Summary

The ideas developed in Chapter 4 on the wave mechanical model of the atom have been melded with the thoughts on the electron and deuteron presented in Chapter 1. The object has been to provide an insight into the structure of the atomic nucleus. The nature, mass and magnetic moment of the proton, neutron and deuteron have been explained. It is to be expected that the properties of atomic nuclei, as aggregations of protons and neutrons, should become explicable on this theory. Though this remains to be explained, progress has been made in finding the bonds between such nucleons. These bonds appear to be electron-positron chains and this is evidenced by the essential role played by the pion in their formation. The pion latches on to a heavy basic particle, a nucleon, and so releases a binding energy which is enough to account for the self-energy of the pion and provide a surplus needed to create the chain. The result is that the mass effect of the binding energy, being negative, just over-compensates the mass of the pion itself and that of the related chain forming one of the bonds between the protons and neutrons. The result, of course, is that any atomic nucleus appears from its mass relation with other atoms to be a mere aggregation of neutrons and protons and little else. The fact that pions, which have significant mass, can appear to come from nuclei is, therefore, no longer perplexing. This problem has been overcome, with the most encouraging result that the length of the electron-positron chains forming the bonds has to equal the lattice spacing of space–time for the pion binding energy to a nucleon to provide the right answers.

The calculation of the energy released in neutron to proton decay has been an important feature of this chapter. The prediction of the existence of a fundamental particle, the so-called H particle, is important. The indication that it can have two forms, one slightly less massive than the other, can have important bearing upon the explanation of the packing fraction curve in further development of this account.

Electron spin has been discussed. Anomalous properties of the electron are consistent with the ideas presented in the analysis of the magnetic moments of the proton, neutron and deuteron. Also, the argument was linked with the explanation of the gyromagnetic ratio presented in Chapter 2. This in turn involved further support for the basic features of space–time as outlined in Chapter 6, since the analysis in Appendix III has a basic dependence upon these features.

We must next turn attention to the magnetic properties of much larger bodies. Terrestrial magnetism can be explained without difficulty from the same principles as used above. This is pursued in the next chapter. It shows that gravitation is not the sole link in the application of this new concept of space–time to both the atom and the cosmos.

8. Cosmic Theory

Geomagnetism

The discovery of the pole-seeking properties of the lodestone antedates the discovery of the phenomenon of gravitation. It is quite remarkable that the great progress of physical science in the past hundred years has not been marked by a wholly acceptable account of these two fundamental properties of the earth. In this work, new comprehensive explanations for gravitation and ferromagnetism have been presented, but to meet the challenge of the lodestone we now need to understand geomagnetism. Even though ferromagnetism can be explained, whether by Heisenberg's theory or the author's theory in Chapter 3, we have no explanation of the earth's magnetism. It is true that there is a theory of hydromagnetism, but this has hardly been accepted. Large astronomical bodies rotating at significant speeds all exhibit intrinsic magnetism. Some, the sun is an example, exhibit a magnetic moment which reverses direction from time to time. Such behaviour is hardly accountable for in terms of hydromagnetism. Hydromagnetism has been reviewed in detail by Elsasser (1955, 1956).

It is of interest to see whether the theory introduced in the foregoing pages can offer a better explanation. There is some encouragement to believe that it may, because there is the immediate question of what happens to the Hypothesis of Universal Time if the "clock", meaning the cyclic motion of the lattice particles, is rotating, as with the earth. Clearly, as the earth rotates, the space–time within the earth rotates as well. The particle lattice rotates as a whole and so does the continuum. Thus, there is basically a balance of charge in motion. The gravitons, electrons and energy medium do not have to share this earthly rotation, any more than they share the linear motion of the space–time lattice. These latter space–time constituents define the inertial frame of reference. Apart from this, the lattice particles do have to rotate at their universal angular velocity Ω to keep in register with the harmonious motion of all space. Now, how can the particles within the earth's aether do this if the whole lattice which they form has to rotate with the earth? The answer to this is simple. To keep in register they have to undergo a slight radial displacement. This will be understood by reference to Fig. 8.1.

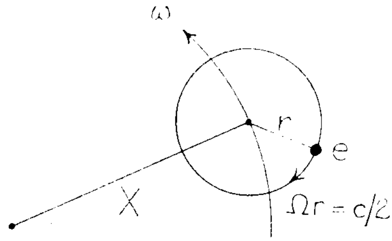

Fig. 8.1

Imagine a particle to be describing its regular orbit at a distance X from the centre of the earth as it moves with the earth about the earth's axis of rotation. The axes of the two motions are deemed to be parallel. Then, compounding the two components of particle velocity, we find that, as the particle rotates, its orbital speed in its space–time orbit varies between $c/2+\omega X$ and $c/2-\omega X$, where ω is the angular velocity of the earth. For constant angular velocity of the particle relative to the inertial frame, a condition we associate with the harmonious motion or in-register state of the particles, the variation of the above speed has to be accompanied by a proportional variation of the radius of the particle orbit. The radius is found by dividing the orbital speed by the angular velocity $c/2r$. Thus, the radius varies betwen $r(1+2\omega X/c)$ and $r(1-2\omega X/c)$. It follows that the whole orbit of the particle behaves as if its radius remains unchanged but its centre has been displaced radially with respect to the axis of the earth by an amount δX of $2\omega Xr/c$. This means that the effect of the charge e is changed as if the charge were simply displaced by this amount.

Now, although the charge continuum and the lattice particles are aether rotating with the earth, there is good reason for believing that there are unbound particles moving through the earth and compensating its linear momentum effects of its space–time due to its motion about the sun. This was implicit in the explanation of the perihelion anomaly in Chapter 5. Thus, we are free to expect that the electrostatic effects of the charge displacement can be wholly balanced by an appropriate distribution of these free charges. The electrical balance is assured, but the magnetic effects of the displaced charge will not be balanced. The free particles are not moving with the earth as it rotates. They move through the earth to compensate the motion of the earth in its orbit around the sun. This means that there will be some magnetic effect set up due to the rotation of the space–time in the earth.

We will calculate the magnetic moment of this displaced charge. The change in magnetic moment due to one displaced particle is $\frac{1}{2}(e/c)\delta(\omega X^2)$ or $e\omega X\delta X/c$. Since δX has been evaluated as $2\omega Xr/c$, the elemental magnetic moment arising from a single particle is $2e\omega^2 X^2 r/c^2$. Since R may denote the radius of the earth's aether, following the same argument as we used in Chapter 5 for perihelion anomalies, and since there are $1/d^3$ particles per unit volume of the earth's aether, the magnetic moment of the earth should be:

$$\frac{16\pi}{15} erR^5\omega^2/d^3c^2 \tag{8.1}$$

This derivation has involved integrating the function in X over the whole volume of the earth's aether.

The expression can be evaluated quite readily. From (4.1), er is the Bohr Magneton, known from experiment to be $9{\cdot}27\ 10^{-21}$ cgs units. From (6.58), we know that r/d is $0{\cdot}30292$. This tells us that d is $6{\cdot}37\ 10^{-11}$ cm, since e is known to be $4{\cdot}8\ 10^{-10}$ esu. We know c. It is $3\ 10^{10}$ cm/sec. For the earth ω is $7{\cdot}26\ 10^{-5}$ rad/sec. The radius of the earth is $6{\cdot}378\ 10^8$ cm, but since the earth's aether evidently terminates somewhat above the earth's surface, say in the ionosphere, we could round R off at $6{\cdot}45\ 10^8$ cm. This puts the earth's aether boundary 72 km above the earth's surface, at the locality of the lower ionosphere layer. These data give an estimate of the geomagnetic moment, since, from (8.1), our theory suggests that it is $7{\cdot}9\ 10^{25}$ cgs units. In fact, the measured geomagnetic moment is $8{\cdot}06\ 10^{25}$. Again we have excellent results. Of course, it is not exact. We have made some assumptions and these need rectifying. Firstly, it has been assumed that the earth's axis is parallel with that of the motion of space–time. The earth's axis rotates itself. It changes direction by precessing about a mean direction over a long period of time. The earth's axis tends to be tilted relative to a reference direction normal to the plane of the earth's motion about the sun. Thus, one has to accept that there is some angular displacement between the axis of space–time and that of the earth. If θ is this angle of tilt and it is the angle measured relative to the perpendicular to the orbit, θ is 23·5°. This will reduce the estimate of the geomagnetic moment given by (8.1) in proportion to the factor cos 23·5°. This is 0·917. Then, if we also use the uppermost ionosphere layer as the boundary of the earth's aether, which is 250 km above the earth's surface, the geomagnetic moment becomes 8·25 10^{25} cgs units. Clearly, one correction reduces the original estimate, which was slightly low, and the other more than compensates. It seems that if the successive ionosphere layers represent different boundaries of slip of the earth's aether relative to the aether surrounding the earth, then the geomagnetic field can be explained exactly.

There is also the question of whether the field will be of the right form. The magnetic moment might be correct, but will the shape of the field match that measured? Will the seat of the magnetic moment match that observed? This has been discussed elsewhere by the author (1966), but it is important to note here that the earth's magnetic moment comprises the quantity deduced in (8.1) and a quantity in the opposite direction which is exactly double and so gives the same numerical result when combined. This is because we are talking about charge which is *displaced*, but only displaced *in effect*. The result is that there is an effective charge density distributed throughout the earth due to this displacement and the balance of this charge is found at the ionosphere layers. This balance is opposite in sign and will generate its own magnetic moment. In fact, the magnetic moment of a charge at the surface of the ionosphere, as displaced from the volume enclosed, will be opposite and exactly double that calculated above. The total magnitude therefore remains unchanged. Note that the radial displacement of charge is from the axis about which the earth rotates. It is not radial from the earth's centre. For this reason, the effective radius of gyration of the earth's distributed charge is $1/\sqrt{2}$ times the radius of the earth's aether. Remember that although there is magnetic moment, the electric field effects of this charge displacement are not apparent because there are free lattice particles in motion along set paths through the earth, due to the translational velocity of the earth in its orbit about the sun. These charges do effectively compensate the electric field. They do not compensate the magnetic field because they do not share the earth's rotation. This is the whole basis of the account of the anomalous perihelion problem, as explained in Chapter 5.

Jupiter

It is reasonable to ask if we can explain the magnetic moments of other planets. The problem is the provision of adequate data. We need to know the magnetic moment of a large planet spinning at a high rate. Otherwise the magnetic fields produced are too small to be measured. For a large planet, the estimate of the magnetic field may also be indirect. It may depend upon other theory and this could be defective. For example, consider the planet Jupiter. A problem confronting radio astronomers is the nature of radio emission by Jupiter. Whereas thermal action can be regarded as the energy source for generating radio emission by stars, the planet Jupiter has a temperature of $-143°$C and, analysed as a "black-body" radiator, it is found that at a wave-length of 100 cm the actual radiation is 1,000 times stronger than predicted theoretically (see *New Scientist*, March 17, 1966, p. 702). This hardly confirms one's belief in the sources of radio emission by stars. The question is seemingly still an open one. However, looking elsewhere for the explanation, the above article refers to theoretical analysis which attributes the radio emission to "synchrotron emission" produced by electrons moving at highly relativistic speeds close to the velocity of light. On the same analysis the polar magnetic field of Jupiter is believed to be about 60 gauss.

Now, on the author's theory of magnetic moment, as presented above, we see from (8.1) that magnetic moment is proportional to the fifth power of radius and the square of speed of rotation. Jupiter has ten times the radius and 2·4 times the rotation speed of the earth. Since polar field varies inversely as the cube of radius, the polar magnetic field of Jupiter should be about 600 times that of the earth. This is, say, 300 gauss, which is five times that estimated on the basis of Relativistic electron emission. However, the radio emission of Jupiter may not be attributable to electrons assumed to move at ultra-high velocity. Instead, on this theory, it could be due to the reaction effect of electrons responding to provide the reaction energy associated with Jupiter's field. A cyclotron frequency corresponding to an angular velocity of eH/mc does occur and, assuming that this is the source of Jupiter's radio emission, the wave-length will be $10{,}700/H$ cm.

It will be remembered that in discussing the reaction effect of electrons or other charge carriers in the presence of a magnetic field in Chapter 2, the kinetic energy of this reacting charge was deemed to be equal to the magnetic field energy. The operative equation was:

$$\frac{Hev}{c} = \frac{mv^2}{R} \tag{8.2}$$

where e and m apply here to the electron. The angular velocity is the ratio of the velocity v of the electron to the radius R of its orbit when reacting to the field H. This angular velocity is then seen to be eH/mc, as used above.

For Jupiter, if H is 300 gauss the emission frequency will be at a wave-length of 35 cm. If H varies over the disc of Jupiter, decreasing away from the poles, then this wave-length will also vary over a range slightly above 35 cm. Radio emission from Jupiter does appear to be strongest over a range of frequency corresponding to such wave-lengths. Therefore, reacting electrons could well be its cause. However, it is not necessary to expect the electron velocities to be "relativistic". In so far as they can develop motion in harmony they will develop magnetic disturbances and wave radiation. We are not concerned with their emission of energy on this theory.

It is concluded that there is a feasible explanation for the magnetic moment of the planet Jupiter. The account presented explains a rather higher magnetic moment than has been observed indirectly from studies of radio emission. However, it is based upon the same analysis as that used to explain the earth's magnetic moment. Also, it is shown that there is another way of interpreting the indirect evidence of radio emission experiments. Also, this other interpretation adds support to the concepts of space–time on which this work is based and does not involve any assumptions about electrons moving at ultra-high velocities in Jupiter's field.

The Sun

We can next test the theory of magnetic moment of astronomical bodies by applying it to the sun. The sun rotates once every 25 days and has a radius 108 times that of the earth. Its magnetic moment should then be $(108)^5/(25)^2$ that of the earth's magnetic moment, or $1{\cdot}9\ 10^{33}$ cgs units. Estimations of the solar magnetic moment have to take into account sporadic magnetic fields produced in sun spots. A reliable estimate of solar magnetic dipole moment was probably made by Sakurai (1959), who measured it as 5 10^{32} cgs. This is less than predicted, but there has been evidence that the solar magnetic field changes with time. It is believed that in some stars the magnetic field reverses cyclically, in some cases every few days. Thus, though the explanation offered for the solar field is of the right order, it is perplexing to seek to explain the possible reversals. Presumably this variable magnetic moment rules out any question of the magnetism depending upon thermal-electric effects. The theory presented is no worse in this regard than one depending upon magneto-hydrodynamic possibilities. On the other hand, it is at least much better since it gives the right quantitative results. Further, perhaps the reversals can be explained, particularly as the magnetic moment developed on this account is produced by the *difference* between an effect within the rotating system and one at its surface. We will come back to this problem later in this chapter.

The Zodiacal Light

The zodiacal light is a dim glow visible in the night sky in the region of the ecliptic shortly after the sun has set in the evening and shortly before it rises in the morning. It is seen as a cone of light which may rise half way to the zenith and extend at its base along the horizon for an angular distance of normally some 20° to 30° but sometimes as much as 45° each side. Under other conditions the light is evident as a zodiacal band running along the ecliptic normally some 5° to 10° wide but sometimes as much as 20° wide.

Along the zodiacal band at a point directly opposite the sun there is a region where the band is both brighter and wider than at any other point. This brighter region is known as the gegenshein, or counterglow, and is sometimes seen when the band itself is not visible. The nature of this light is still an enigma. One theory stipulates that it is a reflection of light from millions of tiny meteoritic particles, but this puts the source of light well away from the earth's atmosphere and makes it difficult to reconcile some of the characteristics of the phenomenon.

The new ideas presented in this book could provide an answer. Might it be that the slip between the earth's space–time and the surrounding space–time occurring in the ionosphere regions can generate light? On the theory developed, a cubic lattice of space–time rotates within a surrounding cubic lattice. If the slip occurs neatly and is not spread over a region of turbulence, there could be a disturbance of the electromagnetic reference frame as the lattices 'notch along' relative to one another. If there were turbulence, we might have to expect something to go wrong with the laws of physics over this turbulent region. Since there is no evidence of this, one can reasonably expect an electromagnetic disturbance to be produced at the boundary of the earth's space–time. To calculate the frequency of this disturbance is quite simple. Consider Fig. 8.2. At a point A at the boundary of the earth's space–time, positioned over the equator, the lattice structure of the inner and outer space–time systems are in register. The disturbance frequency here is $\omega R/d$, where ω is the earth's

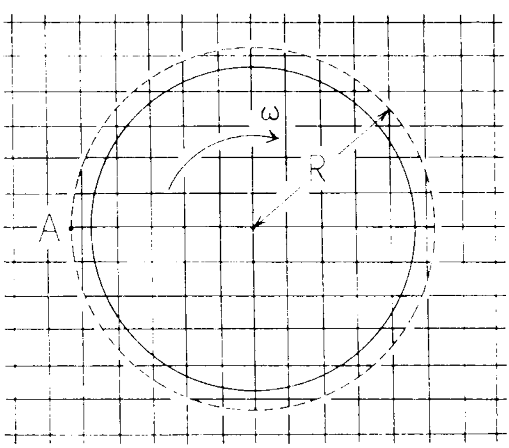

Fig. 8.2

angular velocity, R is the radius of the earth's space–time, and d is the lattice distance parameter. Since ω is $7{\cdot}26\ 10^{-5}$ rad/sec and R is about $6{\cdot}5\ 10^{8}$ cm, we find that the frequency of the boundary ripple is $7{\cdot}4\ 10^{14}$ cycles per second. This corresponds to a wave-length of 4,060 Ångstroms. However, this is an upper limit. When the earth has turned through 45° relative to the surrounding space–time lattice, the ripple action at the boundary will be less, because successive lattice particles are spaced at $\sqrt{2}\,d$. Also, there are factors such as the tilt of the axis of rotation of the earth's space–time, the reduction in frequency if the sky in non-equatorial regions is examined and the possible successive stages of ionosphere slip. Even so, there will be generation of *visible* radiation in the night sky. It is submitted that the above explanation is the answer to the problem of the zodiacal light. The phenomenon has the following features, all of which are consistent with the theory.

1. The visible light frequencies appear to vary in certain regions of the night sky according to different occasions of viewing. This may evidence the interaction of the outer space–time system. The orientation of the lattice of space–time outside the earth system is a factor in determining the frequency of the light generated.
2. The fact that the phenomenon is manifested more in the direction of the ecliptic is consistent with the theory. At positions over the earth where there is high latitude the boundary velocity of the earth's motion is reduced. This means emission of light at lower frequency.
3. The gegenshein phenomenon is more readily explained if the light causing it is generated where it is seen and not reflected from the sun. Assuming that the zodiacal light is generated by the boundary slip process described, it would be more easily seen in the absence of diffused light from the sun, that is, it would be more evident in the region of the gegenshein. Also, however, it would be seen on the horizon owing to the increased intensity resulting from viewing a slip region obliquely.

It is of interest to note that the form of light generation suggested here is different from the action of the photon. It is possible, therefore that such light cannot be traced to any original photon quanta. It is possible that its absorption in photon form will occur, because the photon action is concerned with generation and absorption, but not propagation. The result could be that anomalous effects may occur if one thinks in terms of energy conservation and Planck's radiation law. In short, Planck's law need not, and probably does not, apply to radiation in the form of the zodiacal light.

The Solar System

The orbital angular momentum of the planets is almost wholly due to Jupiter (94%) and Saturn (3·8%). In comparison, the sun has negligible orbital angular momentum and an angular momentum due to rotation of less than 1% of that shared by the planets. By recognizing that the space–time in the sun is rotating too and that it has a mass density of 100 times that of the sun, we see the possibility that the sun might have nearly as much angular momentum as the planets. Ideally, these angular momenta should be equal and opposite. This must be the case if the planets came from the sun by some action wholly contained by the matter of the solar system as we know it. Apparently, this is not possible because the sun appears to rotate in the wrong direction. The reader might feel that there is too much speculation involved in arguing that the core of the sun might be rotating in the direction opposite to that observed at its surface. The surface happens to rotate at different angular velocities at different latitudes. Since angular velocity is not constant, it is not impossible to imagine that the hidden core moves at a different angular velocity to its surface. If this can happen, then it may even rotate in the opposite direction. This is speculation, but we need to understand the problem of balance of angular momentum and the alternative is possibly greater speculation. If the planets were ejected as particles of cosmic matter which has been collected in the locality of the planets, it is curious that all this matter should rotate about the sun in the same direction. Unless, of course, it was thrown off the sun in the direction in which the sun rotates at its surface. The reaction effect is in the sun as a whole. If matter is ejected from a near-rigid sun, the sun would have to rotate in the opposite direction to keep the angular momentum balance right. However, on this basis the successive emissions of cosmic matter would tend to be in random direction and the sun would tend to be at rest. Also, the matter might eventually come back to the sun without going into orbit. By having the core of the sun rotating in the opposite direction to its surface, even before any matter is ejected, we have a system which can prevail and increase in its spin as matter forming the planets is thrown off. This idea can be taken much further, with very interesting consequences, but it is beyond the scope of this work and is, undeniably, speculation, though interesting speculation.

For the time being, the reader may prefer to accept the more conventional ideas involving the influence of some star no longer with us. For example, there is the thought that the planets are all that is left of a large star companion to the sun which exploded. When the dust settled, the earth and the other planets were left behind, sharing the angular momentum of the exploded star. On such a theme Hoyle (1950) wrote:

> So this is the sort of thing that happened to the parent of our planets. Calculation tells us a good deal about its state just before the outburst. The collapse must have gone on very far before this

happened. In spite of the enormous amount of material in the companion star, it must have become considerably smaller in volume than the earth. It emitted hard X-rays from its surface into surrounding space. It was so enormously dense that a match-box full of material taken from its central regions would have contained about 1,000,000,000 tons. Its surface rotated with a speed of about 100,000,000 miles an hour. And the time required for its catastrophic outburst was as little as one minute.

Ideas such as this stimulate the imagination. However, the thought of 1,000,000,000 tons of matter being compacted into a match-box is really taking liberties with Newton's discovery of the law of gravity. It is bold assumption to imagine that, whatever gravity is, the constant of gravitation *G* will, in fact, remain constant under *all* conditions. The ideas about gravitational collapse are all suspect until we can explain the reason behind the constancy of *G* and the *limitations* on its constancy. The analysis presented in this work has, at least, provided an explanation of the nature of gravitation coupled with an evaluation of *G*. Thus, we *can* have the boldness and confidence needed to explore what happens in dense matter. We find that space–time has a density itself. It is not going to be compacted by gravitation in matter, because it provides this gravitation. Its disturbance is the phenomenon of gravitation. It is impossible to have matter compacted to a density of the order of 100 gm/cc and still expect *G* to be constant. Such an idea has no support from experiment and it only comes into modern physics because mathematics allow it and can be applied freely until the physicist discovers the limits to be imposed on the laws formulated. It has to be remembered that so much of theoretical astrophysics is founded upon the physics we know in the laboratory that, if and when limitations are found to be necessary, these may have a profound effect upon what it is *believed* is seen to happen in the outer parts of space. Gravitational collapse is an interesting idea, but to think that massive stars can go on and on collapsing to become a point in space, at which matter of infinite mass density could form, is hardly credible. Yet, if one can believe that sort of thing, one could be prepared to believe that the sun might have a core rotating in the opposite direction to the gases at the radiating surface. Then, the balance of angular momentum in the solar system becomes possible and progress can be made towards further understanding of our creation.

Quasars

The quasar is a star which exhibits a tremendous red shift. The spectral displacement in some cases is found to exceed 0·5. To explain this in terms of doppler effects resulting from the expansion of the universe and the related motion of the star and our system is ruled out. The stars exhibiting the anomaly appear too close for this. To explain the shift as a gravitational red shift, on the theory presented in Chapter 5, requires, for constant G and a mass of the order of that of the sun, that the density of the star should be about 10^{16} times that of the sun. The quasar is then a potential anomaly, even on this theory.

We have an answer, however. Gravitation has been shown to be an electrodynamic property. It is due to the disturbance of electric charge in the G frame of space–time arising indirectly from matter in the E frame. We have not considered the effect of a charge which happens to be pushed into the G frame. Our study of the break up of the deuteron in the previous chapter showed us that in such nuclear situations charged matter could move transiently over to the G frame. We will thus analyse the effect of a charge e, sitting in the G frame and constituting a disturbance. Immediately, since the polarity of the charge is the same as that of the continuum in the G frame, we see that there is an effective gravitational mass due to e of $e/\sqrt{G}$. Remember that the G frame moves at velocity c relative to the E frame. The force between two parallel-moving charges e is then e^2 at unit distance, ignoring electrostatic action. This is equivalent to G times the product of their effective gravitational masses. Now, if the particle of charge e is a positron, we see that transiently its presence in the G frame will increase its mass by the factor $e/m\sqrt{G}$, as measured gravitationally. This is 2 10^{21}.

It follows that if, say, one part in 2,000 of an atom makes such a transient contribution in a nuclear situation, 10^{18} is a measure of the increase of the effective constant of gravitation if all atoms are in this nuclear state. Now, to explain a red shift of 0·5, if one of this magnitude existed on the sun, we would need G to be greater by a factor of 250,000. Thus, one atom in 10^{13}, say, would have to be in the nuclear reaction state. This, then, may be the difference between the sun and the quasar. It is merely a question of the degree of nuclear activity in process.

The Origin of Matter

Nuclear processes must occur in stars. However, this does not mean that the creation of matter on a really fundamental basis involves nuclear action. Nuclear action is the transmutation of matter between its various elementary forms. It is known that atoms can change their form and release energy. Hydrogen is an atomic form able to release energy by forming other elements. Accepting that there is hydrogen already in existence in a star we can expect that there will be energy available for radiation as the hydrogen converts into heavier atoms. This leads to the belief that a star radiates energy by virtue of the nuclear processes of atomic transmutation. Nevertheless, this belief is founded upon assumption. If it is necessary to recognize that there is a more fundamental process by which hydrogen itself is created, it is not improbable that there could be energy surplus to this non-nuclear reaction. Then, on the assumption that a star may be in its creation phase, it is possible that energy available for radiation may, indeed, have its origin, for the most part, in a really fundamental process, different from that currently accepted.

The idea of space–time already presented requires the presence of electrons, negative lattice particles, positive gravitons, an expanded uniform continuum of positive charge and an electrically-neutral energy medium. The latter medium forms the inertial frame, whereas the negative charge constituents define an electromagnetic reference frame, the *E* frame, and move harmoniously about the inertial frame in balance with the positively-charged substance forming the so-called *G* frame. The gravitons are compact and have a high energy content. As space–time expands, the gravitons can expand. Energy is available. However, there is a fundamental balance between the number of gravitons and the number of lattice particles in the space–time system studied. The analysis has shown that we can calculate the relative masses of the lattice particle, the electron and the graviton. Due to the dynamic balance conditions, the ratio in the numbers of these particles in the *E* frame and the *G* frame is a definite quantity. It cannot change merely because space–time expands. The graviton cannot change into some other form, unless this condition of balance is kept. It can be retained provided the transmutation of the graviton is accompanied by the related large number of lattice particles moving out of their normal *E* frame positions. This corresponds to a linear motion of the space–time lattice with the reverse flow of *free* lattice particles, already discussed in Chapter 5 by reference to the perihelion anomaly of Mercury. It is also the key to reconciling the Michelson–Morley experiment with the aether form of space–time. The only problem with this graviton energy release process is that it implies an ever increasing translational motion of the space–time lattice in the vicinity of the graviton. It appears that the motion of a space–time lattice is a characteristic associated with matter in motion. Consequently, the gravitons in the vicinity of matter are the favoured ones to accept the expansion possibilities accompanying the expanding universe. Matter is created from space–time in the vicinity of other matter. The velocity in space of such matter has to *increase* to keep the balance condition. On this basis, stars should have a translational motion through space–time. They could be the seat of energy transfer from space–time to matter form, and their translational velocities should constantly increase. If they are clustered together, their increasing velocities will cause them to move in a spiral sense. This may explain the spiral form of some galaxies.

It is natural to suppose from this that in a star the process of deriving matter energy from space–time energy is proceeding steadily. What is the property, however, which determines the nature of a star? It is suggested that there is something special about a star which is conducive to the graviton expansion process. Possibly other bodies, such as the planets, can increase their mass slowly by a less active participation in the graviton decay process, but, in a star, a large and highly energetic system has passed through a critical size and the graviton decay has become accelerated. A high energy state might permit polarity inversion in space–time itself, and this might allow rapid graviton reaction. By polarity inversion of space–time we mean polarity change from a space–time in which there are positrons and positive lattice particles forming the E frame, and negative gravitons and negative continuum forming the G frame. The E frames of the two types of space–time would need to move 180° out of phase to keep gravity acting across the boundaries, with the harmonious motion condition of universal time unaltered. This brings us to the hypothesis that the sun might comprise, in addition to its matter content, systems of space–time of both polarities. By having this, there are two advantages. Firstly, there is scope for explaining the reversals of the solar magnetic field. Secondly, there is scope for considering reactions involving graviton decay in the presence of electrons, positrons, and lattice particles of both polarities. This is the only feasible way one can come to provide the sources of the electron-positron chains, deduced in Chapter 7 as key components in atomic nuclei.

Terming the two space–time forms positive or negative, one can say that if positive space–time rotates clockwise whilst an adjacent negative space–time rotates anti-clockwise then both will develop magnetic moment in the same direction. Equation (8.1) shows that magnetic moment of the rotating space–time is proportional to volume times peripheral velocity squared. Thus, for a system of regions of space–time in general contact so that their peripheral velocities are all about equal, the total magnetic moment will be the same as if the whole space–time volume rotates with the same peripheral velocity. This is provided positive space–time rotates in the opposite direction to negative space–time. If this is not assured because the polarities can invert cyclically for some reason, then the magnetic moment can fluctuate and can have either direction, subject to the limit on the total magnetic moment as calculated from (8.1) on the basis of a single space–time form. In Fig. 8.3 it is shown how

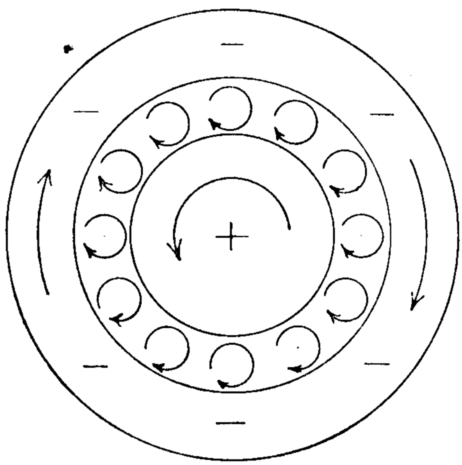

Fig. 8.3

different forms of space–time may be formed in the sun. The outer space–time shell is assumed to be of negative form rotating as is seen from inspection of the sun's surface. The core of the sun comprises positive space–time rotating in the opposite direction. Intermediate space–time zones rotate with a kind of idler-wheel action. If these zones comprise negative space–time, the maximum magnetic moment is to be expected. If, however, the polarity fluctuates in a system, which, of course, will be turbulent and by no means as simple as that depicted, fluctuations of magnetic moment are bound to occur. The angular momentum must remain constant, but could be oppositely directed from that judged by observation of surface velocity. Also, if the core is substantial in size, the angular velocity of the core would be somewhat higher and in the opposite direction to that observed at the surface. This would be highly consistent with the requirements for balance of angular momentum in the solar system.

Such thoughts are mere speculation. Our objective is really to justify bringing electrons and positrons as well as lattice particles of both polarities into account in the matter creation process. The fact that we have come to expect this to occur at the boundaries between positive and negative space–time, and that such boundaries are to be expected within the sun, is the result emerging from the speculation. This introduces the analysis of the true mass of the graviton. It has to have a certain energy to be able to undergo transmutation at the boundary between the two types of space–time.

Derivation of Graviton Mass

It has been suggested in Chapter 6 that the formation of the muon is connected with graviton expansion. Also, in Chapter 7 we have seen how large numbers of electrons and positrons are required to provide bonds in the atomic nucleus. It will now be supposed that at the boundary between the two polarity forms of space–time two gravitons of opposite polarity react together to store the energy of a muon on the lattice particles in the E frame. The loss of the gravitons makes a great many lattice particles of both polarities unstable in their E frames. Many become free and many are available to absorb the surplus energy released by the graviton expansion.

The buoyancy of the lattice particles storing the muon energy is reduced by their compression. This means that, not only has the muon energy quantum to be balanced by a similar quantum in the G frame, but, also, extra energy in equal measure is needed in the G frame to balance this loss of buoyancy. It follows that the energy of three muons 5062 m_oc^2 is deployed from the two gravitons, leaving the remainder of the energy surplus to provide electrons and positrons.

When several lattice particles are compressed slightly to store the energy of the muon, their total volume reduction is $d^3 - 4\pi b^3/3$. The two gravitons and, of course, their associated electron and positron expand to determine two new units of volume d^3 in forming two new lattice particles and related continuum. Two units of expanded space–time are generated when two gravitons decay in the manner described. Matter is formed as a product of this space accommodation process. Allowing for the volumes of the initial electron and positron, the volume of space required for the deployment of the surplus energy is $d^3 - 4\pi b^3/3$.

Let g denote the energy of the graviton. Then $2g - 3(5{,}062)\ m_0c^2$ is the energy needed to compact enough lattice particles to take up the volume $d^3 - 4\pi b^3/3$. When one lattice particle is compressed into an electron or positron its volume is reduced by $4\pi(b^3 - a^3)/3$ and the energy required is $2mc^2 - 3\ m_0c^2$. This energy requirement follows because the electron needs its own rest mass energy and the secondary energy to sustain the G frame balance. As explained in discussing the processes in which electrons and positrons are transmuted, the energy available from a lattice particle is $2\ m_0c^2$ from the E frame and m_0c^2 from the G frame. This is due to the buoyancy effect of the energy medium, which makes the dynamic mass of the lattice particle only half that found for other particle forms on the basis of their electrostatic energies.

It is seen from the above that we can write:

$$2g - 3(5{,}062)\ m_0c^2 = N(2mc^2 - 3m_0c^2) \tag{8.3}$$

$$d^3 - 4\pi b^3/3 = 4\pi N(b^3 - a^3)/3 \tag{8.4}$$

where N is the number of lattice particles converted to electron or positron form. Note that to conserve charge we must have N as an even integer. Also note that in this process we have taken lattice particles from the E frame. If we take lattice particles from the inertial frame, that is the unbound particles in free motion, we are involved in many difficulties of angular momentum and energy balance. It seems that the energy relation (8.3) is best kept in the E and G frames to conserve angular momentum. This means deployment of E frame lattice particles in the initial reaction processes. However, the muons are unstable and there has to be deployment of E frame lattice particles anyway, since many go into the free state, so our equations look well founded. From the data we have for d, b and

a, (8.4) gives a value of N slightly less than 5,065. If N has to be an integer, one then sees from (8.3) that g is slightly less than 5,064 mc^2. This result is consistent with the empirical value of 5,063 mc^2 presented at the bottom of page 119. In a reaction in the laboratory environment we must expect single gravitons, with their associated electrons, to provide the nuclear energy quantum. In such reactions the electron is separated and must take with it an amount of energy adequate to provide the G frame balance originally provided by the graviton. The energy left is 5,063 mc^2.

A value slightly less than 5,063 mc^2 gives the right answer for the constant of gravitation in (6.73). Therefore, this evaluation of the energy of the graviton is reasonably satisfactory. However, even the small difference thus obtained requires explanation. The best explanation which the author can offer is that there has been error in neglecting the presence of free particles. The constant of gravitation G is measured in the solar system. It may be very slightly dependent upon the general motion of the solar system in the galactic reference frame. Also, the energy of the graviton may, indeed, vary with this motion. After all, the graviton is carrying the secondary G frame energy due to the presence of matter. If its energy can be so varied as matter passes by it, then its base energy quantum, which is the unit under analysis, may have some dependence upon the motion state of the space–time present. To calculate this, let there be a translational motion of the space–time lattice at k times the speed of light c. Then, since the reverse motion of free lattice particles is at the velocity $c/2$, the orbital velocity they have when in the E frame, there are $2k$ free particles for each bound particle in the lattice. These free particles will distort the lattice in their vicinity. Assuming that $2k$ is small, there will be substantial regions where one can ignore the presence of free particles and there will be localized regions where significant distortion will occur. Above, we are trying to calculate the value of the graviton mass energy, as set initially. The graviton energy is being calculated from analysis of the reaction process, but it does not depend upon this process. The factor k will affect N as derived from (8.4), unless we can apply the analysis to regions devoid of free particles. This seems logical. The value of g cannot vary according to the presence of free particles. Hence, it must have the value of something just smaller than 5,064 mc^2, notwithstanding the factor k. Accepting this, we turn back to Chapter 5. It is seen that G, as given by (5.12), is increased in proportion to the square of σ. Now, σ does depend upon the presence of free lattice particles. It has to be greater, the more free particles there are, to allow the general analysis to remain applicable. It must be greater in proportion to $2k$. Then, G is increased in proportion to $4k$, whereas, to keep G the same, the mass of the graviton has, according to (5.12), to be increased by one-eighth of $4k$. In other words, all is well with the analysis if the discrepancy between 5,063 and 5,064, which must be explained to reconcile (6.73) with the above evaluation of g, is simply equivalent to the factor $0{\cdot}5\ k$. This means that k has to be two parts in about 5,064, or that the space–time velocity involved is this fraction of the velocity of light. The velocity of the space–time system has to be about 120 km/sec. This, of course, is only rough approximation, but the theory does indicate that the earth should have a motion relative to surrounding space–time of this general order. This means that cosmic background radiation referenced on this space–time electromagnetic frame, if isotropic, should evidence a relative motion by the earth of this order of 120 km/sec.*

On this evidence, one can see that this theory has tremendous scope for application to cosmic phenomena. As shown, the value of the mass of the graviton can be deduced from the theoretical foundations of the theory, and, indeed, the right value is obtained to provide the quantitative explanation of the constant of gravitation. This is a result which is totally beyond the scope of the Theory of Relativity, and one on which the author bases his beliefs that the theory under review is the correct theory of gravitation and that the Theory of Relativity has nothing to contribute to the understanding of gravitational phenomena.

Perihelion Motions

From (6.69), the value of the lattice spacing d can be calculated in terms of the known parameters of the electron. From (6.63), the mass of the lattice particle is known in terms of the mass of the electron. Hence, we can calculate the mass density of the lattice of space–time. It is 144 gm/cc. Note that it was shown from (5.9) that the anomalous motion of the perihelion of the planet Mercury could be explained if the mass density of the space–time lattice were to be

* It is reported in *Nature*, June 7, 1969, page 971 by E. K. Conklin that measurements of the cosmic background radiation show the earth to be travelling at 160 km/sec.

about 150 gm/cc. The theory has, therefore, excellent support from the perihelion anomaly.

It is appropriate to check (5.9) as it applies to the earth. Using the value of space–time lattice density of 144 gm/cc., and noting that the earth has an average mass density of 5·52 gm/cc and a radius of $6{\cdot}378\ 10^8$ cm, the value of the earth's "anomalous" perihelion motion should be given by;

perihelion motion	*R*
5·2	$6{\cdot}45\ 10^8$
5·4	$6{\cdot}50\ 10^8$
5·6	$6{\cdot}55\ 10^8$

The perihelion motion is given in seconds of arc per century. *R* is the radius of the earth's space–time lattice. One has to conclude that the theory indicates a perihelion advance of perhaps 5·4 seconds of arc per century. This compares with the observed anomaly according to Clemence (1948) of 8·62 seconds of arc per century. The earlier-derived anomaly according to Doolittle (1925) was 2·52 seconds of arc per century, but Doolittle used an assumed mass of Mercury, in calculating the perturbation of the earth's motion, of 1/7,500,000 times the solar mass. Rabe (1951) has shown that the mass of Mercury is 1/6,120,000 times the solar mass. The effect of this is to increase Doolittle's estimate of the earth's perihelion anomaly to 5·0 seconds of arc per century. Further, since Clemence used an assumed mass of 1/6,000,000 times the solar mass, his figure should be reduced slightly. It has to be remembered that the measured anomaly is hardly accurate on such analysis. It can be said, however, that the explanation afforded by this theory is better than the value of 3·83 seconds of arc per century afforded by Einstein's theory.

For the planet Venus, this theory gives a value of the order of 15 seconds of arc per century for a radius of about 6,000 km. Clemence obtained a value of 15·15 seconds of arc from observation, and the radius of Venus is somewhat greater than 6,000 km, probably 6,100 km. Nevertheless, bearing in mind the uncertainties in observation and the indirect analysis in such observations, it is appropriate to claim that this theory does offer a feasible account of the anomalous perihelion behaviour of the planets.

Summary

After demonstrating the power of this theory in explaining phenomena associated with the atomic nucleus, we have come in this chapter to the problem of the cosmos. The concept of a large volume of space–time in rotation with an astronomical body has been explored. The principle that the harmonious cyclic motion of the lattice is retained, notwithstanding such rotary motion, has provided an explanation of the nature of intrinsic magnetism in such bodies. The geomagnetic moment has been explained quantitatively, with remarkable results. The principles have been extended successfully to Jupiter and the sun. The idea that the earth has a space–time lattice terminated in the ionosphere has been explored in relation to the zodiacal light. An explanation of the generation of light at the boundary between the earth's space–time and surrounding space–time has given the right quantitative results. In considering the solar system, further support for the theory has emerged since the balance of angular momentum in the solar system is feasible, if we recognize the presence of space–time. The reversals of the magnetic field of the sun have been explained. An account of the extra-gravitational properties of the quasar has been outlined. Also, we have been led to consider the origins of matter and to the thought that there are opposite-polarity forms of space–time. In this way the reactions which are the source of matter, and probably cosmic radiation, have been analysed. The mass energy of the graviton has been deduced and found to be in agreement with that derived empirically earlier in this work. Finally, a little more has been said about the perihelion anomalies of the planets. These have been of such importance in supporting Einstein's Theory of Relativity that they have deserved rather special attention in the analysis. In fact, the observational data is in such doubt that exact analysis has not been possible. Yet, exact analysis is a real strength of this theory, as has been shown in earlier chapters where basic physical constants have been calculated. It is concluded that this theory will have potential in the cosmic field, and that it can claim to be a unified theory since it does embrace basic principles of field behaviour and has application from the sub-atom to the galaxy. This concludes this work, save for a discussion of some general features of the theory in the light of recent discoveries. This discussion is the subject of the next chapter.

9. *General Discussion*

Relativity

The theory presented in the foregoing pages has developed steadily over several years. It will continue to develop, no doubt, at least as long as the author can see scope for its further advancement and has not been confronted with any refuting evidence. Certainly, the theory is not in its final form. This book is a stage in its development. In this final chapter some features worthy of review and which have emerged, in the main, after the previous chapters were written, are presented. Some are reserved for this last chapter because they have not yet stood the test of time and are perhaps more speculative than the main body of this work. This chapter is also the place where some questions can be asked. The anticipation of a few questions might help the reader's understanding.

Proceeding in this vein, we first pay attention to the subject of Relativity. Relativity is synonymous with the name Einstein. This book is entitled *Physics Without Einstein* because the theory presented offers an account of physical phenomena which does not need Einstein's theory at all. However, the author was not motivated to produce an alternative to Einstein's theories when he embarked upon these researches. The motivation was the understanding of a problem in magnetism and the pursuit of an idea concerning ferromagnetism, a subject not remotely related to Relativity. What is described in this book emerged as the author came more and more to believe in the aether medium. It was this belief which made Einstein's theory a factor to consider. According to Relativity, we can get by without speaking of the aether, though, as some say, Einstein's theory is a theory of the aether. Mathematically, there is no need for the physical aether. According to the author's theory, we can get by without speaking of Relativity. Physically, there is no need for sterile mathematical principles. It all depends upon one's outlook, and the reader can only be guided by whatever it is that suits him best. In this book, the author has made extensive use of the words "space-time". These words are used instead of "aether" simply because the reader might find them more acceptable. A well-known physicist advised the author that it was better to use "space–time". He said: "There is an aether, but it gets people's backs up to refer to it; it is better to call it 'space–time'." Having said this, the author does offer one comment to correct any false impression. The aether has come to have a classical meaning in people's minds. There are fixed ideas about the properties of the aether of the last century. It is a kind of mechanical medium providing the single and absolute reference frame in space. Yet, the aether should really be nothing more than that something which fills space. Its properties are a matter for observation, not preconception. All that has to be believed is that space is not a void, it is a kind of plenum. The words "space–time" imply a less definite notion of what it is that permeates space, and their use is, therefore, more consistent with the author's objectives. The question of whether space is a void or a plenum is not a matter of opinion. Philosophers can go wrong in wrestling with such a problem in the absence of factual information. The early Greeks believed that there had to be a void as, otherwise, there could be no motion. Commenting on this, Bertrand Russell (1946) has written in his *History of Western Philosophy*:

"*It will be seen that there was one point on which everybody so far was agreed, namely that there could be no motion in a plenum. In this, all alike were mistaken. There can be cyclic motion in a plenum, provided it has always existed.*"

The author's theory has shown how everything observed in fundamental physics can point to the existence of a cyclic motion, harmonious, universal and constant through cosmic time. Bertrand Russell's observation is, therefore, most important. He points out that philosophers can be wrong in interpreting the physics of space, even when using simple words as explanation. How much scope is there then for error in the mathematics of Relativity? Mathematics can be wrong when incorrectly applied just as words can be misleading if wrongly used. Can we really accept Hoyle's comment, quoted in Chapter 5, that "there is no such thing as gravitation apart from geometry"? The answer to this is that scientists have accepted Relativity as the explanation of gravitation. Perhaps they are a little unhappy with some of the recent discoveries, which do cast some doubt upon the theory, but it is still common belief that Relativity, if in a slightly modified form, is the tool for explaining the phenomenon of gravitation.

This introduces the next comment in a discussion. The question is why any alternative to Relativity is needed. If it gives satisfaction, why develop a new theory which lacks the elegance of Relativity and which presents ideas of a tangible aether having special properties which seem to depend upon too much hypothesis. Logically, whether or not there is an aether is not a matter of mere choice to a true physicist. It could be optional to a mathematician. If there is a tangible substance filling space, we may or may not need to refer to it in our efforts to unify physics. Relativity tries to avoid it, almost by cancelling its effect out of the mathematical equations. This is all very well, but the unification we all seek has not been forthcoming. There are too many mysteries in fundamental physics. Gravitation and electromagnetism were not unified by Relativity, much as Einstein and others have tried. In the field of elementary particle physics there is developing frustration because the theories are not advancing fast enough to cope with the experimental discoveries. The thought of unification in physics seems, therefore, that much more remote. Relativity has to advance rapidly if it is to adapt to the wider developing spectrum of fundamental physics.

The author's theory is an alternative to Relativity and, as has been seen, it covers the whole spectrum of physics, from the nature of elementary particles to gravitation on a cosmic scale, besides covering field theory and wave mechanics. However, where does this leave Relativity, if the author's theory comes to be accepted in its present or a modified form? One comment conceded by the physicist today is "General Relativity may be wrong, but Special Relativity is as firmly established as ever." It would be an easy matter to pass over this question of the validity of Special Relativity. In the words of Einstein (1921), the "principle of special relativity" can be expressed in the following proposition:

"*If K is an inertial system, then every other system K', which moves uniformly and without rotation relatively to K, is also an inertial system; the laws of nature are in concordance for all inertial systems.*"

Newton's mechanics can be used to show that this principle applies to mechanics. The question is whether it really applies to electromagnetic phenomena. A practical aspect of the principle is that it is not possible, if the principle is true, to determine the velocity of a system in uniform motion, without reference to something outside the system. Any measurement within the system should not permit evaluation of motion of the system relative to something else. Now, in the previous chapter, it was suggested that a very small difference between the mass of the graviton expected from the set number ratios of space–time and the mass needed to explain the value of G, as measured on earth, can be explained by the motion of the solar system in our galaxy. This means that analysis and experiment wholly performed in the earth laboratory can indicate the velocity of about 120 km/sec of the earth system in galactic space. This velocity can be measured separately from a study of the optical behaviour of surrounding stars. The fact that a similar result is obtained from direct observation and from the internal observation and analysis, if given credence, is wholly inconsistent with the assumption that special relativity precludes the determination of motion of one inertial system relative to another.

Einstein has jumped from an observation based upon mechanics and inertial frames of reference to one which involves electromagnetic wave propagation and electromagnetic frames of reference. The Michelson–Morley experiment is his key support. However, this experiment relates only to the observed behaviour of electromagnetic waves in the test apparatus of the laboratory. In detecting the velocity of the solar system, we can use the whole of the system as our laboratory. The velocity of light transmitted between the planets is our concern. Does this move at the velocity c relative to the solar system or relative to the space–time medium permeating space between the planets? There is new experimental data of importance to this question, and it may well disprove Einstein's Special Relativity. It stems from some unexplained problems in observations made by new radar measurements, as will be explained below.

The author has explained the Michelson–Morley experiment on the basis that an astronomical body might have its own aether, or space–time, rotating with it and having a boundary some distance above its surface. This idea might sound old fashioned, but it is different from the idea of aether drag. Aether drag implies a slip or turbulence of the aether medium at the surface of a body. It is reminiscent of the attempts of Miller (1925) in performing the Michelson–Morley experiment at high altitude on Mount Wilson. Miller did not obtain the null result found normally. However, the results, though definite, did not indicate the full slip to be expected if the experiment were performed fully outside the earth's aether. It may be that the Theory of Relativity had become so well accepted by then that it did not fit the pattern of progress to pay attention to a small aether effect, which, notwithstanding the experimental care and skill of Miller, could be left for possible verification and likely rejection by others. This remark should be read in conjunction with some comments by Whittaker (1953), who writes:

"The idea of mapping the curved space of General Relativity on a flat space, and making the latter fundamental, was revived many years after Whitehead by N. Rosen (1940). He and others who developed it claimed that in this way it was possible to explain more directly the conservation of energy, momentum, and angular momentum, and also possibly to account for certain unexplained residuals in the repetitions of the Michelson–Morley experiment (reference to Miller, 1925)."

One may well wonder about the support for Special Relativity in the face of admitted weaknesses in General Relativity. If General Relativity collapses, the residuals in the Michelson–Morley experiment cannot be dismissed in this way. Then surely Special Relativity is open to question.

Now, to avoid this type of discussion, we can argue that, though there could well be some degree of aether slip between the earth's surface and the ionosphere, it would be risky speculation to explore that topic here. The author's theory does not require anything other than the null result of the Michelson–Morley experiment so long as it is performed anywhere in an earth-based environment. The earth's ionosphere is the boundary of the earth's aether. This is not an assumption made by the author to dispose of the Michelson–Morley problem. The quantitative analysis of the geomagnetic moment made it necessary to have the earth's space–time boundary at the appropriate height. Even so, a critic may then ask whether we can detect the motion of the earth's space–time. Would not a radio wave grazing past the earth through the earth's space–time not travel faster or slower, according to its direction, in comparison with one travelling just outside this medium? The answer is affirmative and, of course, the author's theory stands to be tested from such experiments.

We can consider whether experimental data are available from the delaying of radar waves grazing past the sun's surface. This is particularly interesting because it has bearing upon the recently reported tests of the Dicke–Brans theory, put forward as an alternative to the General Relativity of Einstein. Early in 1968, it was reported that a new and fourth test to verify Einstein's General Relativity quantitatively had been made by Shapiro and his collaborators. This is summarized by Gwynne (1968). The experiment consists in measuring the effect of the sun's gravitational field on a radar beam passing close to it. General Relativity predicts that the gravitational field should slow down the beam. The delay for the return journey of a radar pulse passing the sun in transit between earth and Mercury, a journey lasting about 25 minutes, should be of the order of 160 microseconds, depending upon how close the beam comes to the solar surface. As Mercury moves into and out of conjunction with the sun, the delay should rise gradually to a peak over several days and then fall in a similar manner after conjunction.

Now, before commenting upon what was actually observed, the reader is asked to consider two separate possibilities suggested by the author's theory, but which have, of course, not been taken into account in the reported analyses. Firstly, if the solar system is moving at a high velocity through space and if light waves travel *relative* to the medium in space, the sun will move appreciably during the period between the close transits of the outward and inward beams. If the sun has an aether extending some distance above its surface then it could be that one direction only of the beam might pass through this aether, causing the beam to be retarded or accelerated in its overall journey. Note that a transit distance of some half-million miles through the sun's aether rotating at a peripheral velocity of about 1·25 miles per second, the surface velocity due to the sun's rotation, implies a delay or advance of about 18 microseconds. This is found by noting that the beam is in transit at the extra velocity of 1·25 miles per second for a little less than three seconds, the time taken to traverse half a million miles at the speed of light. The time of 18 microseconds is the time taken to cover the 3·4 miles added in these few seconds. It follows that any errors of the order of 20 microseconds in the experimental observations are of interest to the author's theory. Secondly, if the sun moves through space at a high velocity, the path of the outward beam will not be where we expect it to be. It is the return beam which is seen in proper relation to the position of the sun. The distance of the beam from the sun in its close transit is important to the estimation of the Relativistic estimate of the delay, or to any estimate dependent upon the effect of solar gravitation. If the beam is not where we believe it to be, the theory is misdirected. To understand this, consider Fig. 9.1. Assume that the whole solar system moves steadily relative to the surrounding medium through which radar waves are propagated at a velocity c subject to solar

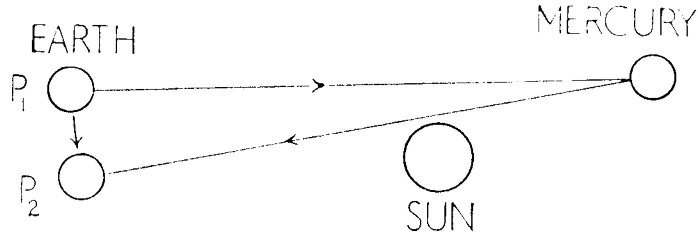

Fig. 9.1

gravitation, as explained in Chapter 5. In the figure, the earth is deemed to be at P_1, when it transmits a radar signal to Mercury. This signal is reflected when Mercury has the position shown, so the reflected radar signal returns along the linear path shown. Since light travels at the same speed as radar waves, the sun has the apparent position shown, at the time the radar beam passes it on its return journey. The return beam reaches the earth when the earth is at P_2. The radar beams are not truly linear near the sun, owing to the gravitational deflection, but we assume that this is allowed for in the separate calculations made in connection with the experiments. Also, the planets are moving within the solar system and doppler effects have to be accounted for. Our objective is only to consider corrections to be imposed upon the measurements if the motion of the solar system through a surrounding aether medium is introduced. From Fig. 9.1 it can be seen that the motion of the solar system is accounted for by the motion of the earth from P_1 to P_2. Because of this displacement between P_1 and P_2, there is a separation of the outward and inward radar beams adjacent the sun. However, we only see the position of the inward beam in relation to the position of the sun. Consequently, depending upon the direction of motion of the solar system, and depending upon which side of the sun the planet Mercury is seen, the outward radar beam will pass closer or further away from the sun than we believe. The result should be an increased overall delay of the radar signal on one side of the sun and a decreased overall delay of the radar signal on the other side. In any event the peak signal will be reduced in its total delay indication, because when one beam direction grazes the sun, the other is spaced away from the sun. This tells us that the observed delay should be less than that predicted and also that it should be shifted in phase as measurements are made over the period when the planet Mercury passes through conjunction. Furthermore, the results will depend upon the time of year when the observations are made. The solar system is moving in a certain direction in our galaxy. Sometimes this direction will have a maximum component, possibly at right angles to the radar beams. At other times it will have a minimum component in this direction. Thus, sometimes there will be a significant phase shift, whereas at other times of year there will be a less significant phase shift.* If the solar system moves at 230 km/sec, as believed, then since the two transit times between the sun and Mercury total about 400 seconds, we are speaking of a distance which could be as much as 90,000 km. This is enough to modify the gravitational calculations of the effect of the sun upon the radar beams by one or two per cent. This is small but, probably more important, could be the effect of bringing one beam outside the sun's own space–time. 90,000 km is significant enough for us to expect this. Then there could well be the 18 microsecond effect mentioned above and it would also correspond to the phase-shift just mentioned. Furthermore, if the velocity of the solar system were directed along radar beam paths, then, on such occasions, the outward and inward beams would both pass inside or outside the space–time of the sun. Then, there would be no modification of the delay.

It may be concluded that any evidence of anomalous delays of 20 microseconds or so is evidence possibly pointing to the galactic motion of the solar system and the rotation of the sun's own space–time. Any evidence of a phase-shift of the delay on some conjunctions and not others is strong evidence in support of both these features. If these properties are found then we may have means for estimating the speed of the solar system in our galaxy as well as its direction. If the measurements are made wholly within the frame of reference of the solar system, as they are, then we have evidence disproving the Principle of Relativity and proving the existence of the aether.

In the reports of Shapiro's 1967 experiments, as quoted by Gwynne (1968), it is clear that:

1. The measured delay was about 10% less than that predicted on Einstein's theory,

* There will also be a doppler shift and a slight deflection when a plane wave passes through rotating space–time. The doppler shift will result in an amplitude pulsation at very low frequency due to wave interference effects. A pulsar may be a star seen through a rotating space–time region located between the earth and the star.

2. The April–May measurements showed a lower peak delay and a distinct phase-shift of one or two days between the observed delays and those predicted from the apparent positions of the sun and the beams,
3. The August–September measurements gave higher results and showed little or no phase-shift, and
4. It was claimed that there were a number of "*slowly varying systematic differences in the results* (*about 20 microseconds on average*)", and stated that these have not yet been explained.

The author merely suggests that these radar experiments *might* provide the long-awaited test of aether theory. It might be that, quite apart from the author's interpretations providing a possible alternative to Relativity, we already have the elements of the proof that Einstein's theories are invalid. It should not, however, be overlooked that the author's theory does give the same result for the gravitational deflection of light waves and the gravitational delay of radar waves in transit past the sun. What the author is pointing out is that there are corrections which have to be made to overcome the scatter on the measurements. These corrections are not available to Einstein's followers. Their use depends upon the recognition of a real aether medium. When they are made, it looks as if the formulae of the Einstein analysis and the author's analysis are correct, but Relativity has then lost its coherence. The author's theory may then have to be favoured. In making the corrections and finding a corrected result in line with Einstein's values, a result will emerge which is out-of-line with the proposals of the new Dicke–Brans theory, which predicts a smaller delay in the radar experiment of about the right order, but which does not explain the phase-shift effects.

Returning to the problem of the effects of aether drag, it has been suggested to the author that the assumption of a local aether is contradicted by the observed aberration of fixed stars. Due to the motion of the earth about the sun, distant stars appear to move in orbits approximately 20·5 seconds in angular radius. This is to be expected since the orbital velocity of the earth of $10^{-4}\,c$ gives a value of the angle through which the star appears to move of arc tan 10^{-4}, in agreement with observation. It is contended that if aether is dragged by the earth no such aberration would be expected to occur. Also, the author has been told that the Fizeau effect provides evidence supporting Einstein or Lorentz theories. Experiment shows that with respect to the laboratory the velocity of light in water moving with velocity u is increased by $u(1 - 1/\mu^2)$, a result predicted from the relativistic addition of velocities. μ denotes the refractive index of water. With aether drag it is supposed that the velocity increase would either be the velocity u of the water or zero, according to whether aether is merely being dragged by the earth or dragged by water. Now, if this type of comment is typical of the general reaction to the author's proposals, the author can but ask the reader to take note of the fact that many phenomena were explained once in terms of aether theory. The aether has gone out of fashion and new text-books have been produced with all kinds of proofs that Relativity can be applied to explain phenomena. So much so, that even phenomena which once supported aether theory are taken to prove the validity of Relativity. Books on electrodynamics are regularly based upon Relativity as the starting point. The results are fascinating, but they cannot displace history. Aberration was discovered in 1725. If Bradley's aberration experiment ruled out the thought of aether, would there have been the tremendous interest in the nineteenth century that was displayed in aether theory? The light from the star is refracted at the boundary between the earth's aether and surrounding aether. Bradley's result fits the author's theory very nicely. The Fizeau result was explained on aether theory before Einstein was born. The velocity of light within a transparent medium in motion is determined partly by the properties of the substance and partly by the properties of the aether. Refractive index μ is c/c_1, where c_1 is the velocity of light measured relative to the substance and c is the velocity of light in vacuo. Then, two densities can be specified. The density ρ of the aether medium in vacuo and ρ_1, the effective density of the combined medium of aether and the material substance. In this sense, we can take density as something proportional to $(1 + \varphi)$ in equation (6.32), so that, from this equation:

$$\rho_1 = \mu^2 \rho \tag{9.1}$$

As Whittaker (1951, c) explains, Fresnel assumed (9.1) and that when a body is in motion the part of the total density in excess of that of vacuous aether is carried along with it, whilst the remainder remains stationary. Thus, the density of aether carried along is $(\rho_1 - \rho)$ or $(\mu^2 - 1)\rho$, while a quantity of aether of density ρ remains at rest. The velocity at which the centre of gravity of the aether within the body moves forward in the direction of propagation is therefore $(\mu^2 - 1)/\mu^2$

times the velocity of the substance, u. As Whittaker also explains, it was many years later that Stokes arrived at the same result from a slightly different supposition. He supposed that the whole of the aether in a body moves together but that, as the body moves, the aether entering in front augments the substance of the body to cause the aether within it to have a drift velocity $-u\rho/\rho_1$ relative to the body. This leads to the same result for the velocity of light relative to the body. This is also consistent with the author's proposal, which admits the space–time lattice to have mass energy associated with it so as to modify its propagation properties. The propagation velocity is fixed relative to the lattice frame in vacuo, but when matter is present, the disturbance of the lattice depends upon the energy of such matter and motion of this matter relative to the lattice. The predicted results of Fresnel and Stokes were verified experimentally by Fizeau in 1851, long before Einstein's ideas about Relativity.

At this stage in the discussion it is necessary to draw the distinction between large bodies, such as the earth, which can take their lattice with them as one rigid unit, and small bodies, such as the moving column of water, which cannot. This distinction is essential, otherwise it would be possible to detect aether properties from measurements on gyroscopes, pendulums, etc. The earth has been rotating long enough and is large enough to have its own special aether. Small bodies in the laboratory are not so priviledged. The author cannot explain, as yet, where the line can be drawn to determine whether a body has its own aether system or not. More experimental research, particularly in outer space, will help to resolve this question, but it is another matter to explain the reasons for any line of demarkation. It is safe to say that in the environment of earthly laboratory experiments the aether lattice appears fixed with that of the whole earth. Aether drag cannot be detected in the laboratory. It cannot be expected to occur. In the Fizeau experiment there is really no special motion of aether. It is simply that the velocity of light is governed jointly by the presence of aether at rest in the earth frame and by matter at motion with a body. To an extent, then, velocity of light can be said to be determined partly with respect to its material source, if it is generated in the earth frame. A gas atom excited to radiate light will, in its own reference frame, "see" the propagation velocity of its waves have some dependence upon its own velocity relative to the earth. For this reason, although the space–time lattice does not move relative to it, there can be doppler frequency shifts according to its velocity relative to an observer. This is in spite of the fact that, as shown in Chapter 4, the photon action is formed in the lattice of space–time whilst the atomic electrons are in their non-migratory state about the nucleus. More will be said about this in the next section.

Electromagnetic Energy Transfer

Not only is Relativity in trouble today. There are increasingly-apparent difficulties with the problems of electromagnetic radiation. The duality of wave and particle theory is a contradiction in physics which has come to be accepted without concern. However, there are other questions. When a photon travels through a material medium is its momentum $h\nu/c$ or does it change as the propagation velocity in the medium changes? The same problem posed by the electromagnetic waves is a matter of concern to Penfield (1966). Cullwick (1966) analyses this momentum difficulty and calls the resulting discrepancy in the formulations "virtual momentum", because "it cannot be regarded as true momentum". Waldron (1966) shows little patience with wave theory by presenting a new corpuscular theory of light; photons and even energy quanta in radio waves are deemed to travel as ballistic particles. These references are all of recent date. They do serve to demonstrate that there is something lacking about our understanding of the processes of electromagnetic energy transfer. The author is, therefore, very much in line with the trend of looking for something better to provide answers to the conflicts surrounding the subject. In the early chapters of this book it has been suggested that waves do not convey energy at their propagation velocity. This sounds heretical, but it is logical if we retain the duality theory. Energy quanta, or, more correctly, momentum quanta, are a feature of the author's ideas about energy transfer. The photon action has been explained in a manner consistent with the evaluation of Planck's constant and the derivation of the basic formulation of wave mechanics. All that the reader is asked to accept is that electromagnetic waves are a mere disturbance of the energy already permeating space. Waves travel without carrying the energy along with them. It is not a new idea. Indeed, the idea that waves need not carry momentum or energy was put forward long ago by de Broglie (1924). It was also proposed by Bohr, Kramers and Slater (1924). The waves become mere disturbances of space and are able to trigger off events involving quantized interaction with space itself. Experimental facts, such as electron-positron creation from the vacuum state, or theories such as Dirac's (1958) ideas about holes in a "sea of charge", all fit together in a pattern encouraging the belief that space itself provides the action and the energy associated with wave propagation, whereas the photon event is merely triggered by these waves. The phenomenon of energy transfer in quanta was expressed quite simply by Eddington (1929, b) when he contrasted his "*collection box*" theory with his "*sweepstake*" theory. When waves are intercepted, do we have to wait until enough energy has arrived and been collected to trigger the photon event? Do we collect energy separately for each frequency before releasing the quanta? Eddington argued that the photoelectric effect disproved this. Instead, he submitted that the waves contribute energy to "*buy a ticket in a sweepstake in which the prizes are whole quanta*". Even here, the physicist has an answer. Experiment has shown that photoelectrons do not accumulate energy transmitted to them by electromagnetic waves, nor do they exchange energy in a kind of sweepstake. The time scale needed for such exchanges makes the idea untenable (see discussion of Yoffe and Dobronravov experiments by Kitaigorodsky, 1965). All the evidence shows that energy transfer is in discrete quanta. The energy transfer is between matter and space or space and matter. In space, electromagnetic waves do certainly appear to exist. Wave theory is so successful in explaining interference and diffraction phenomena. Where the energy quanta come from or go to in photon-wave interaction is not discussed in modern physics. The best we have is the problematic Poynting vector, our tool for understanding how energy is transported by electromagnetic waves. However, we have no insight into the way in which this energy collects and is focussed to generate the quantum. The author has offered an explanation and supported it by quantitative evidence. The reader who does not like what the author is offering in Chapters 1 and 2 has an uncertain alternative in what is already available.

The author has contended that it is absurd to expect there to be energy radiation from the accelerated electron. The absurdity is underlined by pointing out that no accelerating field is allowed for in the analysis and that remote from the electron one relies upon assumptions about energy transfer which have no foundation in truth. Why should we assume that an electromagnetic wave conveys energy? Experiment shows energy transfer to be in quanta. The reader who cannot reject the formulation for the energy radiated by the accelerated electron should ask if it is ever used. Surely, it is used in numerous theoretical treatments. Yet, has it ever been verified? If the formula is applied to a typical radio transmitter and all the conduction electrons in the aerial co-operate in developing a high current at a high frequency it will be difficult to derive enough radiated energy to sustain one photon per minute or per million wave-lengths. To apply the radiation equation and arrive at sensible results, one has to assume collective oscillation of the *collective charge* of all the electrons. Their interaction is vital to the analysis. Therefore, why do we talk about electrons radiating energy? Electric current oscillations generate electromagnetic waves. These are energy oscillations in the aether. The waves are propagated and the waves are the catalyst in the process of energy transfer.

A wave will seldom be produced by one single photon event at the source. In practice, millions of photons of similar frequencies contribute to develop wave radiation. Further, their actions overlap in time, either because the energy release mechanism has a finite lifetime or because the energy is released at different positions in a radiating source and the wave takes time to travel from one such position to the next. This means that even if all the photons produce exactly the same frequency radiation, it is likely that their occurrence is conditioned by the wave itself. The first photon in a series will presumably release its energy without experiencing any external conditioning action, but the wave component developed by this photon must affect the timing of energy release by other photons. Otherwise, their occurrence at random phase will substantially cancel the wave amplitude by their mutual wave interference. It is essential that the existing wave disturbance of the same frequency must influence the time of each photon event contributing to the wave component at this frequency. The photons will, therefore, tend to develop radiation in phase with one another, and will inject their momenta into the radiation field additively.

Now, bearing in mind that photons are liberated from excited atoms, and that such atoms may be moving at velocities of the order of 10^4 cm/sec owing to their thermal energy oscillations, the actual frequency of the wave in the observer's reference frame will differ from that sensed by each atom. This arises from doppler effects. To understand this it is better to think in terms of the key quantity, photon momentum. The frequency of a photon in the space–time reference frame is determined by the momentum imparted to the frame in the energy transfer process. If the atom is moving, the release of more or less energy is needed to develop the same momentum reaction because, relative to the atom, the photon will move at more or less than the speed of light. It moves at the speed of light relative to the frame determined by the space–time lattice and any bulk effect of matter present (a reference to the Fizeau experiment). The frequency of the photon is dependent upon the velocity of the atom emitting it, since momentum has to be velocity-dependent for energy quantization in the transfer process. It is not surprising, therefore, to find a thermal broadening of spectral lines generated by hot gas. The point of this discussion is to show that waves are an essential part of the process of forming photons. The timing of the emission of a photon is conditioned by the phase of waves of similar frequency. The timing of the absorption of a photon is similarly conditioned.

Although it is not necessary to wait until enough energy is collected from a wave before a photon can be absorbed, a certain very small time must elapse. The weaker the wave amplitude, the longer the period during which the absorbing electron is absorbing momentum. In this time the momentum of the electron can change, and in its interaction with the wave one could expect to receive a slightly weaker photon, meaning less momentum transfer or lower frequency, due solely to the very weak wave. It is possible that there could be a frequency shift apparent when waves transmitted over long distances are intercepted. It is absurd to think that the frequency can change in transit between two points not in relative motion. We should, however, not be surprised if measurements of very weak signals indicate an *apparent* frequency reduction. This is worthy of note here because there have been some recent claims that there is a frequency shift of spectral lines in passing massive objects, it being implied that light from stars is caused to lose some of its frequency in grazing past the sun. Such a phenomenon is outside the scope of the author's theory, though it is consistent with the author's opinions to believe that possibly with very weak signals one appears to receive a lower frequency than is really received.

As indicated in the footnote on page 194, the pulsar may possibly be nothing more than a star which happens to be seen through a rotating space–time region. Since it has been shown that an astronomical body can have its own electromagnetic reference frame rotating with it, light in close transit will undergo both gravitational deflection and doppler shift. The two effects will interfere, causing the transmitted light to be amplitude-modulated and pulsate at a low frequency. Pulsars are rare because their line of sight has to pass close to a massive non-radiating, but rotating, astronomical body. The doppler frequency shift incurred by the wave is a function of angle of incidence between the wave and the space–time velocity at interception. But for the gravitational deflection in transit through the rotating space–time, the doppler shift at exit would cancel that at entry. However, the small angle of gravitational deflection causes a small doppler shift in the stellar light seen after transit. This shift varies across the light beam. As a result, parts of the wave interfere at a frequency which is very small. This causes the radiation from the star to pulsate at this low frequency.

The fact that the pulsar is causing such problems to theoretical physicists at this time is merely an indication that they really should rethink some of their ideas about the aether. The above explanation is, of course, rather speculative, but it seems to be more in keeping with the rest of physics than some of the current ideas on the cause of pulsar behaviour.

The Nature of Spin

Spin angular momentum is one of the most perplexing problems. The standard half-spin angular momentum quantum has been assigned to particles without regard to the direct effect on magnetic moment, though with regard to its effect on the measured ratio of spin magnetic moments. Much of Chapter 7 has been founded upon such analysis. Now, how is it that spin angular velocity and spin angular momentum need not be directly related for the right answers to emerge from these studies? An attempt at a reconciliation will be made below, though not without reliance upon hypothesis.

First, in Chapter I the electric charge in linear motion was considered and found to have kinetic energy, magnetic energy and a velocity-dependent electric field energy. These energies were all of equal magnitude, but one was negative. A separate electric field energy exists in association with the charge. It moves with the charge and it determines its mass. One of the positive velocity-dependent energies moves with the charge. It causes mass to increase "relativistically" with increasing velocity. The other two compensating velocity-dependent energies belong to the field or space–time. They are a mere field disturbance. If now such a charge is deemed to be spherical and at rest in the electromagnetic reference frame, what happens if it rotates about an axis through its centre? Is there any magnetic effect? There must be, because we found the right answers for magnetic moments on this assumption in Chapter 7. Since there is no charge outside the spherical surface bounding the charge, the magnetic spin moment must originate *within* the sphere of charge. On the other hand, mass, which is a scalar quantity, unlike magnetic action of a current vector developed by the motion of charge, is related to the electric field energy, the total of which is fixed with the mass and does not depend upon spin. Therefore, when we talk of spin, meaning that the charge is spinning, we expect magnetic effects, but need we expect mass effects or angular momentum? If we do think of angular momentum, are there two components, one due to rotation of charge and contained wholly within the charge sphere, and the other due to rotation of field energy outside the sphere? It can be shown that if we merely assume that all the field energy, within and outside the sphere, rotates with the charge at the same angular velocity, then the angular momentum is infinite. Therefore, we are forced to recognize that any rotation of the field energy outside the charge sphere must involve a limiting boundary or a slip action by which the angular velocity decreases with radial distance.

It seems very probable that there is an angular momentum within the charge sphere due to the charge rotating with its electric field. Also, there must be scope for another angular momentum component determined by the angular velocity and extent of its effect upon the electric field outside the charge. This latter component of angular momentum may well be independent of that possessed by the charge itself within the charge sphere. This argument is consistent with the use of the zero spin condition and its inter-relation with mass in the composite particle forms discussed in Chapter 7. It is also consistent with the assignment of a standard half spin angular momentum quantum to such a particle form. All that this means is that the surrounding field has its own rotation pattern. See also Appendix III.

It is of interest to ask how the proton and the neutron acquire their half spins. In discussing the origins of nucleons it must be remembered that the creation process involves graviton expansion. If one graviton expands to its lower quantum state of mass 3,189 m (see page 140) and then stores the energy of a nucleon of mass of the order of

1,836 m, this graviton can provide dynamic balance and gravitation for the nucleon while still having a total mass and an angular momentum with the G frame roughly equal to those of the normal graviton. This leads to the rule that there is one graviton in close association with each nucleon. The nucleon assumes the spin $h/4\pi$ because it takes up a place in juxtaposition with a graviton and thus replaces an electron of spin $h/4\pi$. In taking up this position it probably exchanges its zero angular momentum state, developed during its creation, with that of the electron. On this basis, the neutron and proton each have a spin of $h/4\pi$, but the deuteron has a double half spin, probably because it forms in the manner depicted in Fig. 7.13 and needs two gravitons to balance it.

Where does the E and G frame angular momentum of the nucleon come from if it only has a spin $h/4\pi$? The lattice particle and the electron have been presumed to have zero or negligible total angular momentum, because spin was in balance with the E and G frame orbital quanta. The quantum $h/4\pi$ is the spin needed by the electron for balance. It is insufficient for a heavy nucleon. By the action of formation of the approximately normal graviton, just described, a quantum of energy of 1,874 mc^2 is released, but this order of energy has to be reabsorbed if the graviton is to provide proper gravitational balance and dynamic balance for a nucleon and other E frame substance. In fact, it is inappropriate to imagine that there are both normal and "approximately" normal gravitons. All gravitons are the same. It is just that, for each nucleon accounting for about 1,874 mc^2 as gravitating mass energy, there is a certain continuum volume adjustment, that is, a continuum charge which can be allowed in the gravity calculation. The gravitational effect of the nucleon mass can, therefore, be catered for without special compaction of a graviton beyond its normal size. Minor volume differences will exist between gravitons in the presence of matter, but on balance the gravitons will retain their basic size, corresponding to their mass of about 5,064 m. It follows that any angular momentum considerations involve us in examining the action of full graviton expansion to form the charge continuum or, at least, some well expanded form such as the positron. Now, the angular momentum of such a graviton is really taken away by the lattice particles which come out of motion with the E frame. They have zero total angular momentum, including their claim to that carried by the balancing graviton. As long as these lattice particles remain lattice particles, there is no angular momentum available. The graviton energy can be deployed into forming some lattice particles as electrons or positrons. This has been suggested in Chapter 8. However, this will do nothing for our angular momentum problem because electrons and positrons have little, if any, residual angular momentum when spin, orbital *E* frame and *G* frame balance are considered. Finally, if we use the energy to form nucleons, there is still no angular momentum available to prime the *E* frame motion. This problem will not be answered. It is a matter for further speculation. Possibly there is a clue from the fact that stars rotate. Where does their angular momentum come from? Can it be that their formation involves a reaction by which the *E* and *G* frame angular momenta of matter and even some of the space–time substance itself is set in balance? This is hypothesis, and best left for the future.

A question of more immediate importance is the explanation of how graviton energy can exist without direct evidence other than the nuclear processes or gravitation. Why is it that matter can move without there being evidence of energy of gravitons moving also? How can the extra energy in space–time which is needed to provide the *G* frame balance for matter in the *E* frame move with this ordinary matter and go undetected? The simple answer to this question is that, when matter moves, electric charge constituting such matter is in motion. Mass in motion requires charge to be in motion. When the energy of *G* frame balance moves, it is being transferred from one graviton to another. Possibly, even, the gravitons are not migrant charges but migrant energy quanta which settle at successive locations by forming the charge continuum into singularities corresponding with the existence of the graviton. Energy in motion need not develop momentum. It has to be carried by electric charge to convey momentum. In this regard the photon is carried by the *E* frame lattice, which is a metric formed from lattice particles, an array of electric charges. It is submitted that one graviton can form by compaction of electric charge as another expands. If the volumes sum to the same amount, before and after this event, then energy has been transferred without the motion of electric charge.

Another problem might seem to be that of gravitational effects of free migrant lattice particles. Such particles are needed to provide the reverse motion balancing the general motion of a lattice. If the free particles are loose in the inertial frame, there is motion relative to the

E frame. How is it that this does not upset the gravitational analysis? Firstly, relative to the *E* frame the linear motion balances that of the continuum charge. There is no resultant electromagnetic effect due to linear motion. There is, in theory, an effect due to the apparent motion of the free particles at the angular velocity Ω relative to the *E* frame. The free particles have deployed their velocity in the *E* frame orbit into a linear motion in the inertial frame. Hence, they move relative to the *E* frame in an apparent orbital sense which should develop an electromagnetic effect interfering with gravitation. To answer this, remember that the linear motion of the space–time system which causes the particles of the lattice to be freed is, in fact, only caused by graviton transmutation. The continuum volumes are adjusted in this process, as matter is created. In fact, the basic parameters of the space–time effects are readjusted. It must, therefore, be assumed that in this process the electromagnetic effects of any free charge are allowed for in the balance, just as the effects of the graviton charge are allowed for.

Electrodynamics

In Chapter 2 the distinction was made between primary charge and reacting charge. The analysis leading to equation (2.8) can be criticized on the ground that reacting charge will have a velocity component in the direction of the applied magnetic field. This makes it difficult to contend that the term K_R is the true kinetic energy. In fact, this problem is merely part of the greater problem that the actual kinetic energy of charge present and available to react may exceed the magnetic field energy requirements. The answer to this difficulty appears to be that K_R is a component of kinetic energy added as a result of the application of the magnetic field. Further, not all free charge can be classed as reacting. All charge is presumably primary unless it is needed for reaction purposes. Heavier free particles will react in preference to lighter ones of the same polarity, but only a proportion of the heavier free particles present may be deflected by the field to become reacting.

This is tantamount to saying that not all free charge in motion in a magnetic field is subject to electrodynamic force action, at least at the same instant. Undoubtedly, this is a difficult proposition to accept, but, if Nature is pointing in this direction, we should not be unwilling to explore its further meaning. Also, the reader is reminded that in this book we are confronting electromagnetic problems, many of which are hidden unnoticed in the subtleties of mathematics in other treatments.

One currently accepted argument is that the diamagnetic moment of free charge is constant (see, for example, *Handbook of Physics*, 2nd edition, 1967, McGraw-Hill, p. 4–193). Analysis shows that as the applied magnetic field increases, electric field induction occurs along the orbit of the reacting charge. This is deemed to accelerate charge to keep the angular momentum, and so the magnetic moment, constant. Kinetic energy increases to keep in proportion to the applied field strength, as equation (2.7) requires if the reaction magnetic moment is not to change.

Now, what does this prove? Does it mean that free electrons in a metal are not diamagnetic? It merely indicates that a single electron will provide a definite magnetic moment in opposition to an applied magnetic field. Diamagnetism, as such, has to do with a multiplicity of electrons. We are concerned in (2.7) with a summation of all the effects of many reacting charges. The reacting or non-reacting state of a particular charge can be determined selectively, as suggested above. Hence, whereas the above regular argument proves that there should be a constant magnetic moment opposing any applied field action, if all charges behave alike, the author prefers the statistical selection as a better alternative. It then becomes irrelevant to argue that the reacting moment of a single electron is unchanged by changing field.

Some authorities require all charge to react in the same way and then invoke statistical argument to explain an overall compensation of magnetic moment. This is contrary to the authority of the above reference which specifies that free electrons react to oppose a magnetic field by developing a magnetic moment which does not vary as the field changes. Complete statistical compensation is, however, impossible to justify. Those who claim it, exemplified by Van Vleck (1957), seem primarily concerned with field-dependence of energy and not magnetic moment. They seem to make their error, a rather grave error, in using a formulation of the form:

$$\sum M = -\frac{\partial E}{\partial H}$$

to show that the energy quantity E does not vary with a change of the magnetic field H when the magnetic moment of free electrons is statistically evaluated. It is a most curious mistake because this formula itself contains the implicit assumption that there is no diamagnetism present. To be correct the value of M should include also the magnetic moment directly attributable to the applied field H. History may one day show that this particular error has been a major set-back to the progress of theoretical physics. It has prevented the earlier development of the analysis on pages 30 and 31, analysis which could have helped considerably in the understanding of the gyromagnetic difficulties later to be discovered.

To conclude this discussion, a few final words could be said about the relevance of the Trouton–Noble experiment to the new law of electrodynamics presented in Chapter 2. The experiment did not involve the translational movement of the capacitor *relative* to the earth. The motion of the earth around the sun was taken as the motion which should induce any manifestation of electrodynamic action. It follows, therefore, that, if the electromagnetic reference frame can be said to be moving with the earth, there is no experimental electrodynamic effect to be expected anyway. As none was found, nothing has been proved. The empirical derivation of the law of electrodynamics is open to criticism on this account. There remains the theoretical derivation and the evidence of its successful application to phenomena, such as ferromagnetism and the explanation of gravitation. These should be sufficient to establish the law. As to the empirical derivation, can it really be expected that a charged capacitor should tend to turn *in its own inertial reference frame* if moved linearly through space relative to an observer? This is an impossibility. It is a contradiction in terms since there could be many observers with different relative linear motions, all involving different amounts of turning action (in different directions) but in the same inertial reference frame. Then, the electrodynamic reference frame alone remains as the reference for such actions. It either moves linearly with the capacitor, or it does not. If there is no measurable linear motion, and there were to be a turning action of the charged capacitor varying according to different uniform velocities of such motion, then Einstein's Principle of Relativity is disproved. It seems, therefore, fairly safe to accept that the experimental data are consistent with the empirical derivation of the new law of electrodynamics presented in Chapter 2.

APPENDIX I

Electrostatic Energy and Magnetic Moment of Spinning Charge

Consider a sphere of radius a containing an electric charge e. The charge distribution within this sphere is determined by the condition of uniform pressure. The electric charge has an intrinsic mutual repulsion and it is constrained against the action of such internal forces to occupy the limited volume of the sphere. Pressure has to be uniform inside this charge. The charge distribution must be radial due to symmetry. Within any spherical shell concentric with the centre of the sphere the charge distribution is uniform over the solid angle subtended. Thus, if e_x denotes the charge contained within radius x and de_x is the charge in the shell of radial thickness dx, we may calculate the outward repulsive force due to their interaction as $e_x de_x/x^2$ from Coulomb's law. This is the force differential across the shell and it must equal the pressure, denoted P, multiplied by an increment in surface area across the shell. This is the differential of $4\pi x^2$ or $8\pi x dx$. From the equality:

$$8\pi P x^3 dx = e_x de_x \tag{1}$$

Since P is constant, it follows from this that:

$$4\pi P x^2 d(x^2) = e_x de_x \tag{2}$$

whence:

$$e_x = x^2 \sqrt{4\pi P} \tag{3}$$

This gives:

$$P = e^2/4\pi a^4 \tag{4}$$

From (3), the electric field intensity e_x/x^2 within the charge may be shown to be constant and equal to $\sqrt{4\pi P}$. The internal electrostatic energy of the charge is then found by multiplying its volume $4\pi a^3/3$ by this field intensity squared and dividing by 8π. The energy E' is then:

$$E' = 2\pi a^3 P/3 \tag{5}$$

From (4) and (5) this is simply $e^2/6a$. This is to be added to the well-known value of the field energy outside the charge radius of $e^2/2a$ to obtain the total electrostatic energy E of the charge given as:

$$E = 2e^2/3a \tag{6}$$

It is to be noted that the charge must adopt spherical form because it would otherwise occupy the same volume and have a higher electrostatic energy. It is the contention of the theory presented in this work that space is strictly quantized. The volume available for the charge e is limited. According to this volume, the energy of the particle is determined on the assumption that it is a minimum. Thus, taking the spherical form as reference, imagine an element of charge to be pushed out to distort the sphere at some point. Then elsewhere an element of charge must receed inwards to keep the occupied volume constant. Electrostatic energy is decreased less for the outward displaced element than it is increased for the inward displaced one. As a result, minimum energy means a spherical charge. This facilitates spin about an axis through the centre of the charge sphere, since rotation about this axis can occur without disturbing the medium outside the sphere containing the charge.

By differentiating (3) with respect to x and dividing by the volume of a spherical shell $4\pi x^2 dx$, it can be shown that the charge density within the sphere of charge varies inversely with distance from the charge centre. The charge de_x of the shell is $2x\sqrt{4\pi P}\,dx$, so, noting that the velocity moment of a spherical shell is $\frac{2}{3}$ times its radius squared per unit angular velocity, the magnetic moment of the charge e becomes:

$$\frac{\omega}{2c}\int_0^a \tfrac{2}{3}x^2 2x\sqrt{4\pi P}\,dx \tag{7}$$

or:

$$\frac{a^4}{6c}\sqrt{4\pi P}\,\omega \tag{8}$$

ω denotes angular velocity. To explain the parameter $2c$, remember that the magnetic moment of unit electromagnetic charge is 4π times its velocity moment times its frequency of rotation, $1/2\pi$ per unit angular velocity.

From (4) and (8), the magnetic moment of the charge e is:

$$\frac{ea^2\omega}{6c} \tag{9}$$

APPENDIX II

Magnetic Field Angular Momentum Analysis

Referring to Fig. 1, consider two charges q_1 and q_2 in close association at O moving at right angles at velocities v_1 and v_2 respectively. The frame of reference is that in which magnetic field reaction is induced. That is, the velocities are measured in the E frame, in the sense in which this term is used in Chapter 4. Thus, the magnetic field induced at a point P distant OP from O may be expressed as the vector sum of two components H_1 due to q_1 and H_2 due to q_2,

Let q_1 be taken as moving along the axis Ox.

Let q_2 be taken as moving along the axis Oy.

Take axes Ox, Oy and Oz as orthogonal.

Let the angles θ, φ, ε, η be as shown.

The magnetic field at P due to q_1 is:

$$H_{1y} = +(q_1v_1/c)\sin\varepsilon\sin\eta/(OP)^2 \text{ in the } y \text{ direction}$$
$$H_{1z} = -(q_1v_1/c)\sin\varepsilon\cos\eta/(OP)^2 \text{ in the } z \text{ direction}$$

The magnetic field at P due to q_2 is:

$$H_{2z} = -(q_2v_2/c)\sin\theta\sin\varphi/(OP)^2 \text{ in the } z \text{ direction}$$
$$H_{2x} = +(q_2v_2/c)\sin\theta\cos\varphi/(OP)^2 \text{ in the } x \text{ direction}$$

Now, imagine that the field due to q_1 exists but that the field due to q_2 has only just been established by q_2 having been suddenly accelerated from rest to assume the velocity v_2. This means that the magnetic field energy density at P changes from $(H_{1y}^2 + H_{1z}^2)/8\pi$ to $[H_{1y}^2 + H_{2x}^2 + (H_{1z} + H_{2z})^2]/8\pi$ as the wave passes. At the point Q it may be shown that the same effect produces a change of magnetic field energy density from $(H_{1y}^2 + H_{1z}^2)/8\pi$ to $[H_{1y}^2 + H_{2x}^2 + (H_{2z} - H_{1z})^2]/8\pi$.

The point now to note is that there is a component of energy density which has to be added in equal measure at P and Q by the passage of the wave. This is $(H_{2z}^2 + H_{2x}^2)/8\pi$. Also, there is a component to be added at P and an exactly equal component to be subtracted at Q. It is:

$$\frac{1}{4\pi}(H_{1z}H_{2z}) \tag{10}$$

As was discussed in Chapter 2, mutual magnetic energy is equal and of opposite magnitude to the mutual dynamic electric field energy. Indeed, the two sum to zero. Electric field energy has mass properties. This follows from the discussion of the velocity-dependence of mass in Chapter 1. We need not think in terms of the motion

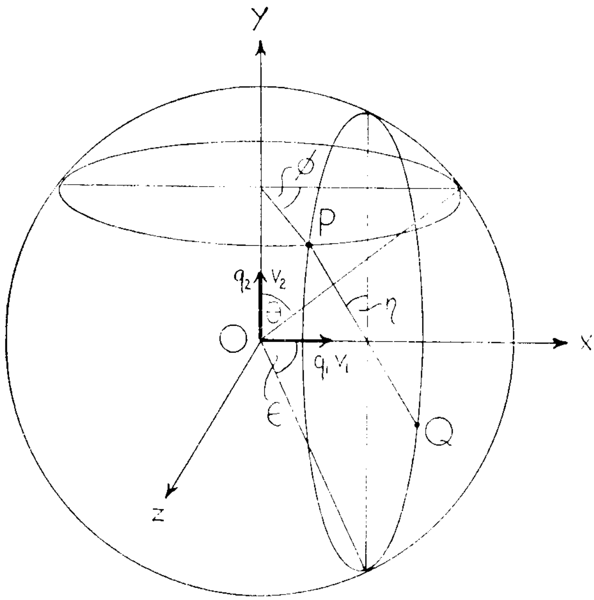

Fig. 1

of magnetic energy. Consequently, in considering the motion of energy and its mass properties, expression (10) represents the energy density of the electric field which has to move from P to Q as the wave passes through these points. This is a measure of the mass *redistribution* in the field. The main energy terms, that is the non-interaction terms, are related to the self energies of the moving charges. The faster they move, the greater their dynamic electric field energies. Hence, the greater their masses, as explained in Chapter 1. Interaction itself does not augment mass in the system shown in Fig. 1. Interaction means repositioning of mass. The passage of the wave can result in angular momentum being imparted to the field energy.

To calculate the angular momentum of this field reaction we note that mass is moving around the wave region about the axis Oz.

Movement from P to Q is through an arc subtending the angle 2ε at radius OP but projected by multiplication by $\cos \eta$. This movement is completed in the time taken for the wave to cross the region contributing to the energy interchange. Let w be the angular velocity of the energy transfer. Then the projected velocity moment is $w(OP)^2 \cos \eta$, and, since w is $2\varepsilon/\mathrm{d}t$, where dt is the time taken by the transfer, this velocity moment is:

$$2\varepsilon(OP)^2 \cos \eta/dt \tag{11}$$

The radial thickness of the region under study is cdt and an elemental volume at P or Q can be formed by multiplying cdt by $2\pi(OP) \sin \varepsilon$ and $(OP)d\varepsilon$. Thus, the elemental energy being transferred between these volumes at P and Q is found, from (10), as:

$$\tfrac{1}{2}(OP)^2 cdt(H_{1z}H_{2z}) \sin \varepsilon \, d\varepsilon \tag{12}$$

We divide this by c^2 to obtain mass and multiply the result by (11) to determine the angular momentum as:

$$\frac{1}{c}(H_{1z}H_{2z})(OP)^4 \varepsilon \sin \varepsilon \cos \eta \, d\varepsilon \tag{13}$$

Substituting now the originally stated values of H_{1z} and H_{2z} gives:

$$(q_1 q_2 v_1 v_2/c^3)\varepsilon \sin^2 \varepsilon \sin \theta \cos \varphi \cos^2 \eta \, d\varepsilon \tag{14}$$

It may be seen from Fig. 1 that:

$$\cos \varepsilon = \sin \theta \cos \varphi \tag{15}$$

From (14) and (15) the elemental field angular momentum given by (14) is obtained in terms of ε and η. When averaged for all values of η, $\cos^2 \eta$ becomes $\frac{1}{2}$. Thus the total angular momentum may be found by evaluating:

$$\tfrac{1}{2}(q_1 q_2 v_1 v_2/c^3) \int_0^{\pi/2} \varepsilon \sin^2 \varepsilon \cos \varepsilon \, d\varepsilon \tag{16}$$

This is:

$$\left(\frac{\pi}{12} - \frac{1}{9}\right) q_1 q_2 v_1 v_2/c^3 \tag{17}$$

Consideration shows that if v_1 and v_2 are not at right angles, as shown in Fig. 1, the expression has to be multiplied by the sine of the angle between them. Thus (17) is a measure of the maximum angular reaction between the charges.

APPENDIX III

Magnetic Spin Properties of Space–time

The lattice particle system of space–time is the electromagnetic reference frame. The charge continuum moving about this frame at the universal angular velocity Ω develops magnetic moment. Here, we assume that this is balanced by the spin of the lattice particles. This spin motion must be in the same direction but it will, of course, have to be at much higher frequency.

From Chapter 2 we have seen that the magnetic moment of any fundamental system in orbital motion has to be doubled. Thus unit charge e of the continuum moving at $\Omega = c/2r$ in an orbit of radius $2r$ relative to the lattice produces a magnetic moment of twice $(e/2c)$ times Ω times $(2r)^2$ or $2er$. From Appendix I the lattice particle spinning at angular velocity ω develops a magnetic moment $(e/6c)b^2\omega$, where b is the particle radius. This has to be multiplied by a factor γ to correct for anomaly. Equating the magnetic moments:

$$\gamma(e/6c)b^2\omega = 2er \tag{18}$$

Next, we note that the spin angular momentum of the lattice particle plus its orbital angular momentum (E and G frame components) sum to zero. The problem here is that the distribution of the angular momentum due to the mass in the field is uncertain. However, we assume that we can apply the same criterion to the mass components defined by and within the sphere of the lattice particle. The field is excluded. Now, the rest mass energy of the lattice particle is $2e^2/3b$, of which $e^2/6b$ is within the sphere of radius b and $e^2/2b$ outside. The effective mass of the particle is halved because of the "buoyancy" due to the density of the energy medium surrounding the particle. Thus, ignoring the field outside the radius b, the effective orbital mass energy of the non-field constituent, to which our zero angular momentum condition is applied, is $-e^2/3b$ due to the buoyancy effect and $e^2/6b$ due to the energy within the sphere. This tells us that the mass effect within the sphere and able to spin at ω is exactly equal and opposite in polarity to that to be considered in orbital motion with the E frame. Note that the field effects and the G frame effects are all separate. Thus, we can equate the spin moment and the velocity moments of the motion, thus:

$$\frac{2}{5}b^2\omega = \Omega r^2 \tag{19}$$

The mass effect within the sphere is uniformly distributed, as shown in Appendix I. Note also that this negative mass effect of the orbital motion is most important for angular momentum balance. Otherwise, the unidirectional motion demanded for magnetic balance due to opposite charge polarity could not be reconciled with zero angular momentum. As it is, the field energy can have counter spin without affecting the magnetic moment and this has important bearing upon the discussion of angular spin momentum in Chapter 9.

From (18) and (19), since Ω is $c/2r$, we see that γ is 9·6. This result is used to evaluate the magnetic moment of the proton in Chapter 7.

The result that the factor relating conventional magnetic moment and true magnetic moment can be 9·6 is, to say the least, most surprising. It ought to be 2, one would think, if the assumptions in Chapter 2, as used to derive (2.7), are to be believed. Let us examine this. Rewrite (2.7) as:

$$H = C - 4\pi k(K_R)/H \tag{20}$$

Keeping C constant and differentiating for maximum K_R gives:

$$C = 2H \tag{21}$$

Then, from (20) and (21):

$$K_R = \frac{H^2}{4\pi k} = \frac{H^2}{8\pi} \tag{22}$$

if k is 2, as in Chapter 2. This result applies strictly to reaction due to *orbital* motion of charge. There is no basis for applying it if the reaction is due to spin. Hence, if the primary field C is developed by charge in spin, any parameter can relate field and charge velocity moment, as far as this particular analysis is concerned. Far from being surprised, therefore, we should be content that a way has been found for deducing the necessary constant in the case of spin. γ is 9·6, not 2, under these circumstances.

As a final word, it is to be noted that the distinction thus made between orbital motion and spin is nothing to do with the geometrical form of any movement of charge. It concerns more the ability of a magnetic field to act upon charge. Magnetic field is physically interdependent upon reaction effects in space–time. It appears that a charge moving in an orbit of radius r, that is about 10^{-11} cm, experiences normal magnetic field actions and so can develop normal magnetic field effects. A charge moving in a path of radius of the order of the electron radius, about 10^{-13} cm, has different behaviour in a magnetic field and so behaves differently in developing a magnetic field. The factor of 9·6 applies to spin and orbital motion of electric charge at small radii, probably even up to radii of the order of the lattice particle and certainly applies to the charge within this particle itself. Whether the factor of 9·6 changes abruptly to 2 at some critical radius, or whether the transition is gradual, is a matter for further research.

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