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:

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

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

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

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

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:

$$4\pi C = \text{curl } H \tag{6.13}$$

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

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:

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

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

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):

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

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

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

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:

$$\text{Energy density times volume} = \text{constant} \tag{6.36}$$

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:

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

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:

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

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:

$$m_o = e^2/3bc^2 \tag{6.39}$$

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):

$$Nm_0r = \rho(x - r) \tag{6.40}$$

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:

$$Nm_0r^2 + \rho(x - r)^2 \tag{6.41}$$

From (6.40), this is proportional to Nm_0rx 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_0rx, 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 inter-particle 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 $0, \pm 1, \pm 2, \pm 3, \pm 4$, 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:

$$I_l = 19{\cdot}040619058z \qquad (6.49)$$

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

$$I_o = 2{\cdot}380077382 \qquad (6.50)$$

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:

$$2\pi(b/d)^2(e^2/d) \qquad (6.51)$$

From (6.39) and (6.44):

$$b/d = (d/r)^2/96\pi \qquad (6.52)$$

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

$$(d/r)^4/4608\pi \qquad (6.53)$$

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:

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

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:

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

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:

$$r/d = 0{\cdot}30289 + 0{\cdot}0657\psi \qquad (6.56)$$

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:

$$\psi = 0{\cdot}000456 \qquad (6.57)$$

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

$$r/d = 0{\cdot}30292 \qquad (6.58)$$

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

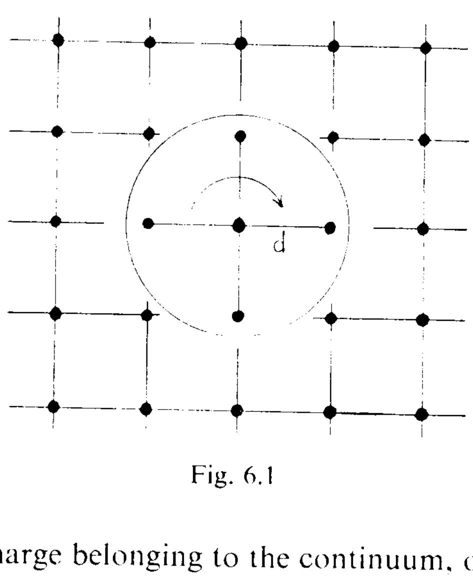

Fig. 6.1

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.

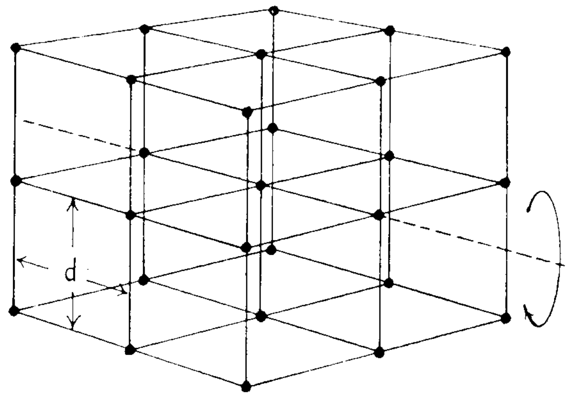

Fig. 6.2

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_0 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 $36m_o d^2$.
From this:

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

From (6.58) we then have:

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

This is a fundamental relation between the mass m of the electron and the mass m_o 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:

$$e^2d^3/4\pi b^4 - e^2/3b \qquad (6.64)$$

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:

$$Km_0c^2 \qquad (6.65)$$

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

$$e = K\sigma d^3/(K+1) \qquad (6.66)$$

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):

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

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 $5{\cdot}273\ 10^{17}$ 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 $0{\cdot}0408$ 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.