6

The Vacuum Particles

The Lattice Particles

The q charges are the particles defining the lattice structure of the space medium permeating the vacuum. As with the graviton and the electron, we assign these particles a radius b which relates their electric energy and their charge q:

$$E = 2q^2/3b \tag{128}$$

These particles have the lowest energy quantum of all particles with the electron-sized charge e. It will be shown that q and e are the same, as we derive the fine structure constant. This least energy state is justified by the fact that the lattice structure of the undisturbed settled vacuum medium must be the ultimate in stability. Furthermore, as part of this hypothesis, we go further and declare that there must be equilibrium between these lattice particles and the surrounding medium. If the energy E is associated with a characteristic spherical volume of $4\pi b^3/3$, then this energy density must be shared by the surrounding medium. Thus, with d as the lattice dimension and d^3 as the volume occupied per lattice particle, we can say that the total energy per unit cell of volume d^3 is given by:

$$E_0 = (1/2\pi)q^2 d^3/b^4 \tag{129}$$

This total energy E_0 is, on average, at rest in the inertial frame, though its nucleation by charge can involve motion and migration throughout the cell.

The effective mass of the lattice particle is not found by using the formula $E = Mc^2$. When E moves there is the effect of a hole in the energy density of the surrounding medium moving as well. This exactly balances the mass property of the lattice particle in respect of its intrinsic inertial action. However, note that the surrounding medium behaves as an incompressible substance. It is like a liquid when subjected to displacement by the motion of a spherical body. We know from the study of hydrodynamics that there is an apparent increase in mass when a sphere is accelerated through a liquid. The formula is:

$$m = 2\pi b^3 \rho / 3 \tag{130}$$

where b is the radius of the sphere and ρ is the mass density of the medium.

Accepting that this analogy applies to the problem of the vacuum, our lattice particles will have a mass given by:

$$m = q^2 / 3bc^2 \tag{131}$$

Here we have used a value of ρ in (130) obtained by dividing E_0/d^3 by c^2, using (129).

The E_0 medium is important, as we shall see later, but, so far as electric interactions are concerned, we can ignore it and proceed to calculate the geometrical form of the lattice structure and its dynamic behaviour.

The lattice particles mutually repel by their Coulomb interaction. As in the formation of crystal structures within matter, we may then expect some kind of cubic or hexagonal lattice to form. This is the minimum energy structure. The problem with this is that the interaction energy is negative. Such an energy condition is possible in matter because the interaction energy terms are mere component terms amongst a whole complex of energy quantities. When we deal with the vacuum state we have to be far more cautious.

The author found that if minimum interaction energy conditions were applied to the space medium and negative interaction energy accepted, then the lattice particles would all be at rest at neutral positions in the charge continuum. There would be no motion. The vacuum would have no character able to relate to time. The exercise of analysing the structure would have been meaningless. Accordingly, the assumption was made that the lattice particles would form in a structure which involves the least possible electric interaction energy consistent with it being positive everywhere.

This meant that there had to be displacement of the lattice particles and motion of these particles to hold them centrifugally in their displaced positions. The kinetic energy then becomes a factor in the energy minimization process. The more the displacement, the greater the kinetic energy. The displacement giving zero electric interaction energy for each lattice particle and equal displacement is the optimum. This meant a simple cubic lattice structure, a structure least favoured in crystals. In its turn this also meant that the problem of analysis was eased.

It was shown in Chapter 5 that x in (86) was $2r$ and that Ω in (86) was $c/2r$. Thus (86) becomes:

$$mc^2 = 32\pi\sigma q r^2 \tag{132}$$

Since the space medium is electrically neutral:

$$q = \sigma d^3 \tag{133}$$

assuming that q is a point charge. A correction for this will be applied later. Then, from (132) and (133):

$$mc^2 = 32\pi (r/d)^2 q^2/d \tag{134}$$

The evaluation of r/d is the prime task at this stage. We know the value of r from (93) and by finding r/d we will be able to determine d and so a value of σ if q happens to be the same as the electron charge. The value of r/d is readily found, because it is set by the condition of zero electric interaction energy discussed above.

The equation of electric energy in the space medium, neglecting self-energy of any particles, is:

$$E = \sum\sum q^2/2x - \sum\int (q\sigma/x)dV + \int\int (\sigma^2/2x)dVdV \tag{135}$$

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 space. x now denotes the distance between charge in this general expression. The inter-particle lattice distance d is taken to be unity, as is the dielectric constant. Boundary conditions are of little consequence. Electric interaction energies, when reduced to local energy density terms, can in no way depend upon remote boundary conditions. The lattice configuration assumed need not hold as a rigid perfect lattice throughout space. It can be distorted, but we do expect the synchronous character of the lattice particle motion to hold over vast space domains.

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 (135), but also depends upon the displacement between the q system and the σ system. The differentiation of (135) with equation to zero gives:

$$\sum\int(q\sigma/x)dV=\int\int(\sigma^2/x)dVdV \qquad (136)$$

From (135) and (136):

$$E=\sum\sum q^2/2x-\sum\int(q\sigma/2x)dV \qquad (137)$$

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

$$\sum q^2/x-\int(q\sigma/x)dV \qquad (138)$$

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

Stage 1: The evaluation of $\sum q^2/x$ 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, 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 $\sum q^2/x$ or $(q^2/d)\sum(l^2+m^2+n^2)$ 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 $\int(q\sigma/x)dV$ 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 $q\sigma/x$ over these limits is denoted $q\sigma d^2I_z$ 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:

$$I_z = 19{\cdot}040619058z \tag{139}$$

Within the I_1 shell there is a component I_0 for which z in (139) is effectively 1/8. Thus:

$$I_0 = 2{\cdot}380077382 \tag{140}$$

Stage 3: Correction for finite lattice particle size.

Equation (133) is not strictly true if we allow for the finite volume of the charge q. For analysis in stages 1 and 2 it was easier to define q so that it satisfies (133). In effect q was made $q+\sigma V'$, where V' denotes the volume of the q particle. Bearing in mind that the mutual repulsion in the σ continuum will assert an attractive effect on a void in σ, we find that this assumption holds rigorously when applied to displacement effects. The point charge assumption is, therefore, quite in order. One correction that is needed is for us to avoid including interaction energy developed *within* the particle volume. The correction term to be subtracted from I_0 is:

$$\int_0^b 4\pi\sigma q x dx \tag{141}$$

This is:

$$2\pi(b/d)^2(q^2/d) \tag{142}$$

From (131) and (134):

$$b/d = (d/r)^2/96\pi \tag{143}$$

Thus, in units of q^2/d, the correction, found from (142) and (143), is:

$$(d/r)^4/4608\pi \tag{144}$$

From the results of the above three stages of calculation, we can now complete the evaluation of (138). Combining the above results we would find that the energy in the rest position is negative. It is the displacement of the lattice particles through the distance $2r$ from the σ continuum that adds the balancing energy:

$$8\pi\sigma q r^2 \tag{145}$$

This is obtained from (38) in Chapter 2. In units of q^2/d it becomes:

$$8\pi(r/d)^2 \tag{146}$$

The value of E given by combining these results, on a per lattice particle basis, is:

$$E = 8\pi(r/d)^2 - I_0 + (d/r)^4/4608\pi - \sum I_z + \sum S_z \tag{147}$$

We now have an expression from which r/d can be evaluated by putting $E=0$. The difference between the two summations in these expressions is readily calculated by comparing (139) with the table of values of S_z. The S terms are all slightly higher than the I terms, but the difference converges inversely as the cube of z. The difference terms, beginning with the difference between S_1 and I_1, are:

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

To sum the series, we match this convergence to:

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

or:

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

for terms from $z=3$ onwards. This sums to 0·00105.

Collecting these figures, we obtain:

$$I_0 + \sum I_z - \sum S_z = 2{\cdot}3137 \tag{148}$$

Then from (147) we can establish that r/d is 0·30288.

Although it has been shown how r/d can be estimated by manual calculation, a value of the zero energy r/d value has been checked by computer in 1972 and found to be 0·302874. The author is indebted to Dr. D. M. Eagles and Dr. C. H. Burton of the then-named National Standards Laboratory in Australia for their initiative in performing these calculations. The results are reported in *Physics Letters*, **41A**, 423 (1972).

Now in the previous chapter we derived the electron g-factor by discovering that there is a resonant cavity in the electron field and this spherical cavity had a radius determined by half the Compton wavelength or, from (93), $2\pi r$. Since we now have an estimate of r/d we can relate the lattice dimension d with this resonant radius. The electron resonant cavity is found to have a radius of $1{\cdot}903d$. This is drawn in Fig. 24 in relation to the space lattice.

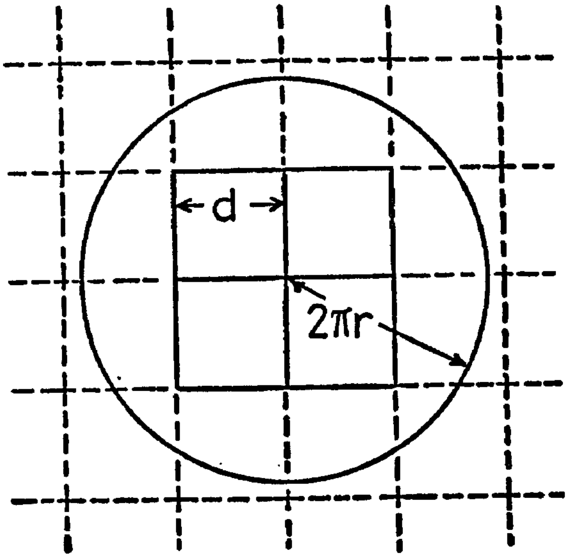

Fig. 24

It is seen that the electron resonant cavity will contain a $3 \times 3 \times 3$ lattice particle array if symmetrically positioned in relation to the lattice.

In deriving the Schroedinger equation we considered an electron in dynamic association with a photon unit, the latter pictured as an array of lattice particles having three-dimensional symmetry. It is then evident that the photon unit could be the very simple unit formed by a $3 \times 3 \times 3$ array of lattice particles rotating about their central member.

From (101) the moment of inertia of the photon unit is:

$$I = 4hr/c\pi \tag{149}$$

because Ω is $c/2r$. The moment of inertia of the $3 \times 3 \times 3$ lattice is $36md^2$, because there are twelve particles distant d from a central axis and twelve distant $\sqrt{2}\,d$. Therefore, equating these values of I:

$$36md^2 = 4hr/c\pi \tag{150}$$

Eliminate m from (134) and (150):

$$h = 144\pi(r/d)(2\pi q^2/c) \quad (151)$$

We know r/d and so have found an expression for h in terms of q and c. The quantitative data seem correct when q is equal to the electron charge e. Therefore, now accepting this, we write (151) in the form:

$$hc/2\pi e^2 = 144\pi(r/d) \quad (152)$$

This is the reciprocal of the fine structure constant. It is a dimensionless quantity determined by the geometry of the space structure.

Next we seek to determine the mass m of the lattice particle in relation to electron mass m_e. Rewrite (106) thus:

$$W = \pi h\nu^2/\Omega \quad (153)$$

W is the kinetic energy of the electron in orbit at angular frequency $2\pi\nu$. From (93) h is $4\pi m_e cr$. Put this in (153):

$$W = \tfrac{1}{2}(2m_e cr/\Omega)(2\pi\nu)^2 \quad (154)$$

The term $2m_e cr/\Omega$ is then the moment of inertia. Since Ω is $c/2r$ this gives the electron a radius of orbit of $2r$. The electron has to describe its orbits at four times the speed of the rotation of the photon units in order to perform the screening action discussed in the chapter on wave mechanics. Its angular momentum balances that of the photon unit. Hence its moment of inertia must be one quarter of that of the photon unit. Thus $m_e(2r)^2$ is equal to $\tfrac{1}{4}(36md^2)$, giving:

$$m/m_e = 4(r/d)^2/9 \quad (155)$$

From the derived value of r/d we find that m is 0·0408 m_e. We will later see that there is experimental evidence supporting such a mass value for the q charges of the space lattice. It is related to the temperature of the cosmic background radiation.

The Virtual Electrons and Positrons

Although virtual electrons and positrons are an essential ingredient in the vacuum medium, they appear to have no direct electrical interaction with other charge, owing to their pairing. They are important energy quanta. When they are created they need space for their charges. Yet we have on two occasions in this work already spoken of the incompressibility of the medium surrounding such charge. The section on the graviton highlighted the need for an incompressible fluid. Early in this chapter we struck an analogy between the energy medium holding the lattice particles in equilibrium and the properties of an incompressible liquid. Therefore, we are committed to think in terms of the conservation of the space occupied when electrons and positrons are created. We have, indeed, three possible binding conditions:

(a) the conservation of energy
(b) the conservation of charge parity
(c) the conservation of space.

How then can we account for the creation of electrons and positrons unless there is a corresponding annihilation elsewhere? The answer to be applied to the vacuum medium is that there is a state of equilibrium asserted between the lattice particles and any virtual electrons or positrons in the system. This has an energy quantum fluctuation associated with it, which interacts in creating elementary particles of matter.

Take one single lattice particle. It has the dominant space volume $4\pi b^3/3$ and little energy, but a single charge e. The electron or positron is the next largest particle in volume. As far as space interactions between the lattice particle and the electron-positron scheme are concerned all other known particles are of negligible size. Thus, for conservation of space in energy exchanges between lattice particle and electron-positron creation, the ratio of the volumes occupied by these particles individually must be an integer. Furthermore, for conservation of charge parity, it must be an odd integer. Thus one lattice particle of charge e can convert into N electrons of charge $-e$ and $N+1$ positrons of charge e, assuming the lattice particle has a positive charge. $2N+1$ is an odd number. But we know that the radius of a charge is inversely proportional to its mass energy. This was the basis of (128). Hence m_e/m, given by (155), when halved and cubed, has to be an odd integer.

The halving is necessary because the mass m is the effective mass of the lattice particle owing to its motion in the incompressible medium. m is half of the equivalent mass energy given by the formula (128). The ratio of the volume occupied by the lattice particle and that occupied by the electron is then found to be approximately 1844·5 and this is not an odd integer.

Accordingly, since it must be an odd integer, we must recognize that the value of r/d is not at its strictly-zero electric interaction energy condition. Minimization of electric potential energy is the requirement, combined with a positive value. From (147) we see that r/d must be increased to the first value that will satisfy the odd integer requirement. The ratio m_e/m must, from (155), be reduced. Obviously, the odd integer is uniquely determined by the physical factors involved. It is 1843. Working backwards from (155) we then obtain:

$$r/d=(3/4)(8/1843)^{1/6} \tag{156}$$

Putting this in (152) gives a rigorous formula for the fine structure constant. We obtain:

$$hc/2\pi e^2=108\pi(8/1843)^{1/6} \tag{157}$$

This gives a value of 137·035915 for this quantity.*

The ability of the vacuum medium to generate energy fluctuations requiring and releasing the mass energy of about 1843 electrons and positrons will be seen to be very important when we consider the creation of the proton. It has direct implications in our quest to determine the mass of the graviton. First, let us evaluate the energy E_0 given by (129). From (143) E_0 becomes:

$$E_0=(1/2\pi)(96\pi)^3(r/d)^6q^2/b \tag{158}$$

From (156) this is:

$$E_0=(3/4\pi)(108\pi)^3(1/1843)E \tag{159}$$

where E is the energy of the lattice particle given by (128). We have shown that this is $(1/1843)^{1/3}$ times the rest mass energy of the electron m_ec^2. Thus E_0 is readily found to be:

$$E_0=412{\cdot}665816\, m_ec^2 \tag{160}$$

This happens to be very close to the energy of two muons, which are heavy electrons with a mass between 206 and 207 times that of the electron. Accordingly, it is tempting to suggest that the unit cell of the space medium comprises a pair of virtual muons in general migration and providing the equilibrium for the energy of the lattice particle.

* B. N. Taylor and E. R. Cohen, in a paper in the Proceedings of the Fifth International Conference on Atomic Masses and Fundamental Constants (AMCO-5), Paris, June 2–6, 1975, note that quantum electrodynamic data can be interpreted to give a value of 137·03592, correct to 0·8 parts per million. However, we must also take note of the more recent evaluation by Williams and Olsen of 137·035963(15) referenced at the end of Chapter 5.

In recent times heavy particle decay has come to be characterized by the emission of dimuons. Indeed the ratio hadrons to muon pairs produced in high energy collisions has become an important parameter in particle physics.

It occurred to the author that one way in which to discover the mass of the graviton would be to suppose that it was a heavy particle which could decay by producing energy quanta E_0 corresponding to a muon pair plus the quanta 1843 m_ec^2, with the residual energy forming hadrons. Thus, in a book published in 1966,* the author proposed that gravitons of energy g might decay into pairs of muons plus pairs of the 1843-quanta plus one or two hadrons. Apart from single graviton decay a double graviton decay suggested by collision seemed possible. The need to separate the hadron energy from the 1843-quanta suggests that the latter escape in pairs to assure momentum balance. Below a tabulation is given of the energy needed to create 1 or 2 muon pairs and 0, 1 or 2 1843-quantum pairs. The former require 412 electron energy units and the latter 3686. An exclusion rule was applied by which the number of muon pairs could not exceed the 1843-quantum pairs by more than one. This excludes the combination 2, 0 as well as 3, 1 and 4, 1, etc.

muon pairs	1843 pairs	energy deployed	hadron product	g energy
1	0	412	2(2326)	5064
1	1	4098	966	5064
2	1	4510	2(276)	5062
1	2	7784	2342	2(5063)
2	2	8196	2(966)	2(5064)

Bearing in mind that we contemplate a decay of either one or two gravitons, inspection of the first three columns of the table tells us that the energy g is likely to exceed 4510, with the fourth and fifth listed decays involving $2g$. The first decay would then leave a hadron energy greater than 4098. This seemed too high from 1966 data to correspond to a single hadron. Accordingly, a pair of hadrons was deemed to be formed of energy $\frac{1}{2}(g-412)$. The second decay suggested that the hadron product would be a meson of much smaller

* H. Aspden, *The Theory of Gravitation*, 2nd ed., Sabberton, Southampton, p. 81 (1966).

mass. There were two candidates, a pion or a kaon. A fit was found by using the kaon of energy value 966 (this is the positive kaon of today of 493·7 Mev). There was a sigma hyperon of mass 2326 (1189 Mev) amongst the few well-known hadrons of the early 1960 period. When a pair of these were put into the first decay, the same g value emerged. Next, the fourth listed decay from two gravitons gave the other mass value of the sigma hyperon family 2342 (1197 Mev).

The author, therefore, felt that the pattern emerging gave evidence of the graviton in the region of 5063 electron mass units (2·587 Gev). This was particularly encouraging because, as we shall soon see, this is the value which gives us the constant of gravitation G.

Furthermore, it had not escaped the author's notice that there was an interesting correlation in the ratios of m/m_e and μ/g, where μ denotes the mass of the muon. This arose because the volume d^3 of the unit cell of the space lattice was about 5060 times that of the lattice particle. This correlation was exploited by the author in his 1966 work to give a theoretical account of the graviton mass, as being 5062·75 times that of the electron. We will see later how this graviton is created in high energy reactions and show that it has connection with the recent psi particle discoveries. First, let us explore a little further the data in the above table.

The third decay seemed relevant as affording enough energy to create two pions, which, in the early references to pion mass, were shown to have a higher value of 276 than that of 273 known today. The fifth decay seemed also relevant as applying to the creation of a pair of kaons.

Data of this kind appeared in tabulated form in the author's 1969 book *Physics without Einstein*. Also, in the author's 1975 book *Gravitation*, in Appendix III, there is an extension of the decay modes. For example, the second-listed decay in the above table can result in the creation of neutral kaons of mass 975 if the 1843-quanta escape only after becoming neutrons of mass 1838·6.

To show the relevance to the constant of gravitation, we now take the expression (54) for G and, by writing u as c and σ as e/d^3, this becomes:

$$G=(6\pi x^4 c^2/ed^3)^2 \tag{161}$$

By writing $m_e c^2$ as $2e^2/3a$, we can rearrange (161) as:

$$G=(e/m_e)^2(4\pi)^2(x/d)^6(x/a)^2 \tag{162}$$

If gm_e denotes the mass of the graviton, then by the standard relationship between mass and size of a particle of charge e we know that x/a is $1/g$. x/d is found using b/d from (143) and a/b, which is $2m/m_e$ and known from (155). x/d is therefore $(1/g)(1/108\pi)$. From this (162) becomes:

$$G=(e/m_e)^2(4\pi)^2(1/108\pi)^6(1/g)^8 \tag{163}$$

The charge/mass ratio of the electron is 5·273 10^{17} esu/gm. We have seen that g is close to 5063. Hence G can be evaluated from (163). It is found to be 6·67 10^{-8} cgs units, in full accord with the measured value. Only one minor correction to (163) seems necessary. The value of σ is really higher by the factor 0·0002 than the formula e/d^3 indicates, owing to the finite size of the lattice particle. Thus the value of G given by (163) needs to be increased by the factor 0·0004.

The theory in its state as developed to 1966 therefore gave a very strong indication that the graviton constituent of the vacuum medium had the mass energy 2·587 Gev corresponding to this g value of 5063.

The H particles

If a charge e of energy P and radius x_1 has surface contact with an opposite charge $-e$ of energy Q and radius x_2 we have a neutral aggregation of total energy E given by:

$$E=P+Q-e^2/(x_1+x_2) \tag{164}$$

Again, using our basic classical energy formulae:

$$P=2e^2/3x_1 \text{ and } Q=2e^2/3x_2 \tag{165}$$

we can put (164) in the form:

$$E=P+Q-\frac{3}{2}PQ/(P+Q) \tag{166}$$

The author used this formula in the 1969 book *Physics without Einstein* to analyze nuclear binding energies, but it was not until five years later that the simple connection between (166) and the proton was realized. In collaboration with Dr. D. M. Eagles* the expression (166) was found to have a specific relationship between P and Q for E minimal and the higher of P and Q constant. This was:

$$Q/P=\left(\frac{3}{2}\right)^{\frac{1}{2}}-1 \tag{167}$$

* *Il Nuovo Cimento*, **30A**, 235 (1975).

When Q was assigned the value E_0 given by (160), P was found to be:

$$P/m_ec^2 = 1836{\cdot}15232 \tag{168}$$

This compared with the known proton-electron mass ratio of 1836·15152(70), the (70) term signifying the probable error in the last two digits.

This encourages us to develop a theory for the proton from this result. The problem is to relate the phenomological basis of (168) with the creation of the energy quantum P. To proceed, let us look back to (166) and imagine that it could represent the merging of two virtual muons. The energy E would then equal E_0. P and Q could presumably have any value but if, for some reason, P was set equal to the energy of one virtual muon or $\frac{1}{2}E_0$ then (166) shows that Q would be E_0. The point is that the Q and P energies can be in a two to one ratio in the aggregation and yet the system appears as a whole to have simply the energy Q. A neutral system has the same overall energy as a charged component and yet contains another charged component of half the energy. This is a most useful formula by which to explore elementary particle physics.

A theme which we will term 'charge interaction stability' will be developed next. The energy formula $2e^2/3x$ applied to all basic charges can be differentiated to relate energy E_x and a change of volume V_x:

$$dV_x = -6\pi(x^4/e^2)dE_x \tag{169}$$

This was the basis on which we obtained (53) in formulating G.

If we have two such identical particles with the same x value, then they can exchange small amounts of energy whilst their combined volume will be conserved. Conservation of charge and space is assured in such an interaction and, apart from the very small second order energy requirements, the overall energy is conserved as well. It follows that there will be a mutual stability between particles belonging to the same family if they are in close proximity. It is logical, therefore, to expect that when a pair of muons combine in the near presence of similar systems they can have a transient stability by which one of the charges retains the single muon energy quantum. Then, from the foregoing argument, the other is thereby also held transiently stable at the double energy quantum E_0 of the whole aggregation.

In their turn such systems afford a measure of stability for E_0

energy quanta of particles in higher energy configurations. The formula (167) is applicable to a system which is energized by one of the 1843-quanta already discussed. As the energy P now set in excess of 1836·152 decays, the energy minimization process within the $P:Q$ system will encourage selective energy deployment between P and Q. This accelerates the progress of Q to its optimum value. When Q reaches the E_0 level its further decay is halted by the stabilizing effect of particles elsewhere in the environment having this E_0 value. This will retard decay of the system and cause the P energy to linger a little at the 1836·152 level before the system degenerates and goes into rapid decay, feeding its whole energy back into virtual electrons and positrons.

The overall result is that in such an energetic environment the creation of E_0 quanta will also lead to the creation of transient particles of charge of energy 1836·152 m_ec^2. The creation process has a kind of resonance condition, inasmuch as a slight tendency for a particular particle form to develop is accentuated by mutual stability effects. These proton-sized particles will be termed H particles. They are important constituents of matter and provide the source from which protons are formed. The proton will be discussed in the next chapter.

Formula (166) has interesting application to the particle forms emerging from high energy collisions between electrons and positrons. The psi particle discoveries reviewed by Drell* in 1975 are particularly important. Formula (166) can be applied to show why the psi particles are generated. This explanation has only recently been presented by the author in a scientific journal† and is hopefully an indication of the firm foundation of the author's theory.

Note that the minimum energy value given by (166) is:

$$E_{min} = P - P(k^{\frac{1}{2}} - 1)^2 \qquad (170)$$

where k is used in the energy expression e^2/kx applicable to a charge e of radius x. k has been taken to be 3/2 in the above analysis. Now, given that P is the energy of the proton 938 Mev, then E_{min} will have a value determined by k. k has to be less than 2 because any higher value puts the charges in closer contact than their radii allow. The range $k=1$ to $k=2$ corresponds to a range of E_{min} from 938 Mev to 777 Mev and there happens experimentally to be only one meson

* S. D. Drell, *Scientific American*, **232**, 50 (1975).

† H. Aspden, *Speculations in Science and Technology*, **1**, 59 (1978).

between 938 Mev and 784 Mev. It is identified as K*(892). It is then gratifying to find that when the value of $k=3/2$ is used in (170) we obtain 891 Mev. This implies that the particle K*(892) arises by the energy minimization process in a paired charge aggregation which includes the proton.

Above we spoke of 'charge interaction stability'. Now we will consider the 'pair creation stability' which we used to derive the 1843-quantum. We saw that the volume occupied by a lattice particle could be taken up by an odd number of electrons and positrons and that this interchange of states could govern the equilibrium between the lattice particles and electrons. When we consider high energy collisions in the presence of energy quanta which are nucleated by charge e and occupy specific volumes of space, then we can expect interactions regulated by such criteria. Thus the graviton energy quantum g could regulate the stability of other high energy particles.

A form of 'pair creation stability' which we will now consider involves particle annihilation at a position A immediately followed by particle creation at a different energy level. Elsewhere at position B there is the reverse process. Energy is exchanged between A and B to assure energy conservation. At both A and B there is charge and space conservation. However, our hypothesis requires pair annihilation at A followed by the creation of two identical pairs at A. Thus the new particles formed at A will have a volume half the size of the other particles. Since energy is inversely related to radius, this means that there can be equilibrium between energy quanta related by the factor $2^{1/3}$. Thus in a g quantum environment we would expect to find $g(2)^{1/3}$ particles once high energy conditions prevail. Also, since two g quanta of opposite polarity are offering their space to four $g(2)^{1/3}$ quanta, two of positive and two of negative polarity, we could expect some hybrids to form, such as one of $g(2)^{1/3}$ with one of opposite polarity of $g(2/3)^{1/3}$. The latter arises from an exchange of the three $g(2)^{1/3}$ quanta for a single quantum occupying the same space when an opposite pair of the higher energy quanta mutually annihilate.

The relevance of this to the psi particles is immediately apparent when we consider an electron and positron colliding at very high energy to provide the energy E in (166). The energy quanta $g(2)^{1/3}$, g and $g(2/3)^{1/3}$ are deemed to be present. They will assert a stabilizing influence on the P and Q quanta generated in the reactions. A very likely resonance condition is one for which E is at the minimum value given by (170) and P is $g(2)^{1/3}$. With $k=3/2$ and $g=2{\cdot}587$ Gev, the graviton energy deduced above, E_{min} is found to be 3·095 Gev, exactly the energy of the first-discovered psi particle.

This is most encouraging. Now let us look for the second most-likely resonance. Here we find E from (166) when P is $g(2)^{1/3}$ and Q is g. With g as 2·587 Gev this gives E as 3·683 Gev, corresponding to the second-reported psi particle. The experimental value finally presented was 3·684 Gev, in excellent accord with this theoretical account.

Finally, let us evaluate the energy of the other particle predicted above. With $g(2/3)^{1/3}$ and g as 2·587 Gev, we obtain 2·260 Gev. The discovery of such a particle of mass energy between 2·250 Gev and 2·270 Gev at Fermilab was announced in August, 1976.*

From the evident relevance of these data to the positive identification of the 2·587 Gev particle, it must be expected that experimental verification of the specific existence of the 2·587 Gev graviton is possible. At the time of writing this book there is conflicting evidence on this point. A very significant particle resonance was reported near 2·60 Gev early in 1977,† but searches made independently‡ have failed so far to give confirmation. Hopefully, the 2·587 Gev graviton will manifest itself more directly in such experiments in the future.

Meanwhile, some further confirmation of the psi particle theory above is forthcoming from data on the staged decay of the 3·684 Gev psi particle published since the author developed the theory.§ The particle has five radiative decay thresholds at 3551 ± 4, 3503 ± 4, 3455, 3414 ± 3 and 3340 Mev, respectively. We would expect that if the author is correct and the psi particle at 3·684 Gev is based upon a P-Q combination, with Q as 2·587 Gev and P as $(2)^{1/3}$ times this at 3·259 Gev then these decay thresholds should be indicated by a connected theory.

To proceed, note that our expectation of decay arrested at succeeding thresholds will involve either P or Q halting at resonant levels at which there is a stabilizing influence from more prevalent particle forms having standard energy quanta. The dimuon energy given by

* N. Calder, *The Key to the Universe*, BBC publication, p. 122 (1977).
† A. Apostolakis *et al.*, *Physics Letters*, **66B**, 185 (1977).
‡ G. W. van Apeldoorn *et al.*, *Physics Letters*, **72B**, 487 (1978).
§ W. Tanenbaum, *Physical Review D.*, **17**, 1731 (1978).

E_0 in (160) of 211 Mev is an example, as is the muon energy of 106 Mev. Also, decay might occur by shedding energy which creates miniature *P*-*Q* systems, referenced on such standard quanta.

Put $P = Q = 106$ Mev in (166) and we obtain 132 Mev. Thus if we take our theoretical energy for the psi particle of 3·683 Gev and suppose that its first decay involves release of a coupled muon pair we are left with an energy 3·551 Gev retained by our degraded *P*-*Q* system.

This is the first decay threshold. At this 3·551 Gev energy the *P* and *Q* constituents, having lost momentarily their stabilizing connection with standard particles in the environment, may oscillate over a wide range of correlated values, exchanging energy between *P* and *Q*. When either *P* or *Q* reaches a low or negligible value, such as that of the electron or positron, it may easily be separated to leave the other constituent charge in isolation at an energy close to the 3·551 Gev threshold. These in turn provide standard energy quanta influencing other *P*-*Q* systems in decay and eventually recombining with a free charge to reform a decaying *P*-*Q* system. Thus we may look for the next decay threshold by setting *P* at 3·551 Gev and *Q* at the muon energy 106 Mev. The value of *E* given by (166) becomes 3·503 Gev, exactly the second psi decay threshold.

By reiteration, with *P* as 3·503 Gev and *Q* as 106 Mev, we then obtain the next decay threshold from (166) as 3·455 Gev. This is exactly the third decay observed.

Alternatively, since *Q* could have been a dimuon at this stage, because 3·683 Gev less 3·455 Gev exceeds the dimuon energy quantum and energy released by decay could have created dimuon systems which assert a stabilizing interaction, we could put *P* as 3·503 Gev and *Q* as 211 Mev. (166) gives then an energy *E* of 3·415 Gev. This is the fourth decay threshold.

Still another alternative, is for the 3·551 Gev system, influenced by the near presence of muons in the miniature *P*-*Q* system formed with this decay, to generate and shed a pair of muons of total energy 211 Mev, thereby leaving an energy 3·340 Gev. This is exactly the fifth decay threshold.

The numerical correlation of the decay thresholds now tabulated in Mev below is quite persuasive, and considered alongside the simplicity of the model used it greatly strengthens the author's thesis that the 2·587 Gev graviton is a reality as an energy quantum characteristic of the vacuum medium.

Theory	Observation
3551	3551 ± 4
3503	3503 ± 4
3455	3455
3415	3414 ± 3
3340	3340

These theoretical results for the decay of the 3·684 Gev psi particle were published by the author in 1979.*

It is of interest to note that in an environment in which these psi particles are created, one might expect other related psi particle forms. The *P*-*Q* system of energy 3·683 Gev could oscillate at this energy, exchanging energy between *P* and *Q*, as we suggested for the 3·551 Gev system. Assume that it does this but halts at a *Q* value of 211 Mev, that is at the dimuon quantum E_0 of (160). Then, for energy *E* unchanged at 3·683 Gev, (166) requires *P* to become 3·772 Gev. This could set an energy threshold for another particle having this energy value.

The discovery of a psi particle having the energy 3·772 Gev was reported in 1977,† another helpful pointer in support of our analysis.

Finally, turning away from the graviton and psi particle topic, but remaining with the *P*-*Q* system, we might consider the merging of two protons, or rather a proton and an antiproton, to create a *P*-*Q* system of total energy twice 938 Mev or 1·876 Gev. Suppose it is unstable and oscillates as suggested before to a limit state in which *Q* is an electron and *P* has the energy 1·877 Gev. Then, imagine energy release as the system settles in its minimum state given by (170). We are left with an energy quantum of 1·782 Gev. This is close to the recently reported energy of another new particle named‡ the tau, of energy 1·785 Gev.

In this chapter we have analysed the lattice structure of the space medium, relying upon the J. J. Thomson formula for charge as a spherical particle having mass energy equal to its electric energy. This formula has been applied universally, but in particular to the *q* charges forming the lattice and the gravitons balancing the lattice. It has been applied to pairs of charges forming *P*-*Q* systems and has

* H. Aspden, *Lett. Nuovo Cimento*, **26**, 257 (1979).
† P. A. Rapidis *et al.*, *Physical Review Letters*, **37**, 526 (1977).
‡ M. Perl, *New Scientist*, **81**, 564 (1979).

helped us to develop strong evidence from the new discoveries in elementary particle physics supporting the concept of the graviton energy quantum of 2·587 Gev. Thus, we have been able to evaluate Newton's Constant of Gravitation G, further strengthening the unification of the forces of gravitation and electrodynamics presented in Chapters 1 and 2. Incidental, it seems, to all this, is the evaluation, from the geometry of the q charge lattice, of the fine structure constant, an evaluation which is good to one part in a million.

It is submitted that there is good foundation for advancing physical theory on the lines introduced so far in this work, and, in particular, for studying the particle theme, bearing also in mind the other incidental result that gave us the H particle mass as equal to the proton mass to within one part in two million. We need, however, to be mindful of the possibility that much of the analysis applies to static and possibly transient situations applicable during creation and annihilation processes. Thus, although it seems that an electron has a solid spherical form most of the time in its low speed state, we have to be open to more complex behaviour in intervening periods.

The task in the next chapter is to examine how the principles developed so far can be applied to particles of matter.