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An empirical approach to meson energy correlation

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An alternative empirical approach, differing from the quark model, is presented for analyzing particle constitution. It relies upon an energy correlation based upon the Thomson charge-mass formula and primary energy quanta, notably those of the proton (938 MeV), the related dimuon (211 MeV), and two graviton-related quanta, denoted g(2587 MeV) and g^*(3259 MeV), respectively.

When confronted with a vast amount of numerical data pertaining to certain physical parameters, the search for a correlation has often to proceed empirically, with only limited intuitive physical justification. Eventually, a viable theory may emerge. The analysis of the line spectra of atoms in advance of the Bohr theory is one example. Particle physics now provides the scope for such an empirical study.

Here, there has been an interesting analysis by MacGregor,[1] who has shown the possible relevance of the fine-structure constant as a logarithmic scaling factor relating particle lifetimes and masses. MacGregor has written extensively on the quarks and subquarks, as constituents of fundamental particles, and in the paper just referenced he identifies lifetime clusters in his empirical system with the decays arising from the annihilation or transformation of unpaired substates, including, for example,

$$Q_0 \approx 70 \text{ MeV} \quad \text{and} \quad Q_3 \approx 210 \text{ MeV}.$$

The annihilation of the subquark $Q_3(210)$ is seen, in particular, as relevant to the Λ, $\Sigma^{\pm}$, Ξ, and Ω hyperon decays.

Following MacGregor's example, we here examine the scope for a fruitful empirical enquiry into the energy constitution of a set of fundamental particles, taking all the mesons listed in a section of the Data Card Listings of the Particle Data Group.[2] These are the nine mesons listed in Table I below. They appear on pages S-160 to S-164 of Ref. 2.

It will be shown how the energies of each of these mesons can be constituted by a plausible particle reaction process, involving essentially two primary energy quanta $Q(211)$ and $g(2587)$ and their derivative forms $P(938)$ and $g^*(3259)$. The numbers in brackets denote energy in MeV. The analysis which follows considers energy components and makes no reference to particle properties, such as charge or spin. The object is merely to show a natural correlation by which the scalar energy parameter characterizing a particle can be determined in charge reaction processes. Such processes may be influenced by the quasistabilizing effect between particles not directly involved in a transformation of states, a subject discussed in an earlier paper by Aspden.[3] The new results reported in this paper are intended to show that the earlier-reported correlations [as between the unitary dimuon $Q(211)$ and the proton $P(938)$, for example, and as between the graviton $g(2587)$ and the psi particles $\psi(3095)$ and $\psi(3683)$] are not fortuitous and isolated examples having restricted relevance.

We will rely upon the basic correlation of energies E_1 and E_2, nucleated on charges e, confined to spheres of radii a and b, respectively, according to the Thomson formulas

$$E_1 = 2e^2/3a \quad \text{and} \quad E_2 = 2e^2/3b \tag{1}$$

when the charges are held in contact at their charge surfaces, by virtue of their opposite polarity. The total energy E of the neutral aggregation is then E_1 plus E_2 offset by $e^2/(a+b)$. From (1) this gives

$$E = E_1 + E_2 - \frac{3E_1E_2}{2(E_1+E_2)}, \tag{2}$$

and for E_1 constant and E_2 variable, E has a minimum $E_{\min}$ when E_2 is $(\sqrt{\frac{3}{2}} - 1)E_1$ and $E_{\min}$ is then $(\sqrt{6} - \frac{3}{2})E_1$.

To simplify presentation, our notation will be that $(E_1 : E_2)$ signifies the neutral aggregation of energy E and $(E_1 : E_2)^*$ signifies the same dual charge unit of energy $E_{\min}$, for which $E_1 > E_2$. In this latter case, if either E_1 or E_2 is specified, the other energy parameter is determined by the mathematical relationship just derived.

We will otherwise rely only on one principle discussed in previous papers.[3,4] This is that there is a mutual equilibrium between charges having the same energy, whether these are part of a complex defined by Eq. (2) or whether an energy in Eq. (2) is influenced by the near presence of a charge external to the complex but in the near vicinity.

The dimuon $Q(211)$ is taken as a basic prevalent quantum throughout space. It may arise because Eq. (2) tells us that $E = E_1$ when E_2 is the energy of a virtual muon and space is deemed to be well populated with pairs of virtual muons. The dimuon $Q(211)$ features in MacGregor's empirical study as $Q_3(210)$. Aspden and Eagles[5] have discussed its role in a theory for the proton/electron mass ratio, because it forms a complex $(P:Q)^*$ with the proton. Note that P is then $(\sqrt{\frac{3}{2}} - 1)^{-1}(211)$ MeV, or 938 MeV. The $P(938)$ energy quantum and $(P:Q)^*$ are clearly very basic units in particle energy building.

The author next appeals to analysis of experimental particle data by LoSecco in 1975.[6] At that time dimuon events in high-energy neutrino scattering had just been discovered. LoSecco demonstrated that these could be caused by the three-body decay of a particle of mass energy in the region of 2.5 GeV. This was in good accord with the author's own theoretical prediction dating from 1966 that a particle of mass 2.587 GeV decayed by shedding pairs of muons to leave energy accounting for the creation of members of the hyperon family.[7] The author's incentive was to obtain empirical support for a theory of gravitation giving the constant of gravitation G as

$$\sqrt{G} = \frac{4\pi}{(108\pi)^3 g^4}\left(\frac{e}{m_e}\right), \tag{3}$$

where g is the graviton mass in terms of electron mass and e/m_e is the charge/mass ratio of the electron. This makes $g(2587)$ a likely primary energy quantum, and a derivative form resulting from energy priming which converts a graviton pair into two heavy graviton pairs was indicated empirically. Note that if space occupied by the charges is conserved in such a transition, the heavy graviton g^* will have an energy related to the graviton g, thus:

$$g^{*3} = 2g^3 \tag{4}$$

From this we find that g^* is 3.259 GeV.

Our task is now to confine attention to the four primary quanta $Q(211)$, $P(938)$, $g(2587)$, and $g^*(3259)$ in showing how other particle energies are constituted.

As discussed in Refs. 3 and 4, the correlation linking with the first-discovered psi particles is

$$\psi(3095) = (g^*:E_2)^*, \quad \psi(3683) = (g^*:g), \tag{5}$$

because 3095 is $(\sqrt{6} - \frac{3}{2})$ (3259), and 3683 is E in (2) when E_1 is 3259 and E_2 is 2587.

Reference 4 extended the theory to show that a number of decay products of $\psi(3683)$ could be explained using Eq. (2) and involving $Q(211)$ and its derivatives.

Note that we are concerned with large energy quantities in comparison with the electron and positron energy quanta, and though we do not make distinction between neutral- and charged-particle energies, it is implicit that an electron or positron could be involved to assure charge priming or neutralization.

When the discovery of the upsilon particle of mass energy 6.1 GeV was announced in 1976,[8] the author noted that $(g^*:g^*:g^*)$ is 6110 MeV. This hitherto unpublished correlation applies to a triple particle group. The dual group of Eq. (2) may be seen to have an energy 1.25 times that of each energy constituent, if they are equal. A corresponding calculation for three identical components gives an energy of 1.875 times each constituent energy quantum. 6110 MeV is 1.875 times the energy of $g^*(3259)$.

With the above introduction we can now tabulate in Table I the nine mesons under review and the correlated energy formulation. It is believed that particle correlations 1, 2, 4, 8, and 9 are self-explanatory from the prior discussion.

Correlation 3 is an evaluation of the energy threshold at which energy shared by a proton P and a unitary dimuon Q will, with their rest mass energies, allow them to create a graviton pair. Conversely, a graviton pair could mutually annihilate to create P and Q and shed an energy quantum, accounting for the creation of the psi particle represented.

Correlation 5 says that two $\psi(3683)$ energy resonance states interact at the same energy level to cause their energy constituents to adopt equal energies X, but that the whole system degenerates by pair annihilation to leave one X intact and put all the rest of the energy into one residual psi particle.

TABLE I

Corr. No.	Particle	Energy Correlation	Energy (MeV)
1	$\psi(3683)$	$\psi = (g^* : g)$	3,683
2	$\psi(3770)$	$(\psi : Q) = (g^* : g)$	3,772
3	$\psi(4030)$	$2g = \psi + P + Q$	4,025
4	$\psi(4160)$	$(\psi : P)^*$	4,173
5	$\psi(4415)$	$2(g^* : g) = 2(X : X) = \psi + X$	4,419
6	$\gamma(9460)$	$4g = (P : Q)^* + e + p + \gamma$	9,456
7	$\gamma(10020)$	$\gamma = g^* + g + \psi(4160)$	10,020
8	$\gamma(10400)$	$\gamma = P + \gamma(9460)$	10,394
9	K(892)	$K = (P : Q)^*$	891

Correlation 6 is similar to 3. It indicates that if an electron e and a positron p are caused to collide with equal energies and the collision involves energy transfer to the basic $(P: Q)^*$ system, the latter system can be split and the four particles involved could all convert into gravitons. The onward decay of these gravitons might appear as four jets in the reaction products.

Correlation 7 is a process in which the $\psi(4160)$ particle engages with the isolated components of a split $\psi(3683)$ particle. Note the precision of the correlation in that $\gamma(10020)$ is $(1 + 2^{1/3})g + (\sqrt{\tfrac{3}{2}} - 1)^{-1}P$, where g is 2587 MeV and P is 938 MeV.

It is hoped that the theoretical energy quanta shown in the last column of Table I will, by their very close correlation with the nominal energies of the meson states listed, assure the reader that we have here the basis for a new kind of particle theory.

Unfortunately, however, the argument concerns only the possible energy levels at which particles are created and completely ignores the experimentally well-defined pattern of internal quantum numbers which the related particles possess. Nor is the question of spin properties and magnetic moment addressed. Nevertheless, by showing how discrete energy levels can become available for particle formation, we have some partial answer to the overall problem.

To reinforce this argument, the author[9] has recently shown how the Thomson charge formula can be used to deduce, quite rigorously, the mass and magnetic moment of the neutron and deuteron in relation to the proton, as well as the neutron lifetime. The theory gives values in precise accord with measurement, even at the part per million level of measurement precision. Furthermore, in a separate paper[10] the same energy analysis has been used to derive all the energy levels of the intermediate particles in the electron-proton energy spectrum.

To show the further power of the theory, the method used will now be extended to derive the energies of a baryon group below the energy levels of Table I. This involves consideration of charge pair annihilation within triple clusters of tau and muon leptons.

Equation (4) assumed that charges could transform their states in reactions which conserved the space they occupied. This idea is crucial to the theory under discussion. It resembles, in some respects, a theory discussed by Johnson[11] concerning a quark confinement process (the bag model) in which ordinary space is pushed aside in order to inflate bubbles enclosing the quarks. Trell[12,13] has extended these ideas in terms of a volume-preserving transformation of a spherical ground state, from which he deduces baryon mass relationships, including the correlation $1 : \sqrt[4]{3}$ for the proton : delta mass ratio.

Earlier, Aspden[3] showed that the mutual interaction of charged particles assures a quasistability, owing to the volume conservation process, and that pair annihilation within a three-particle cluster involves an energy adjustment in the ratio $\sqrt[3]{3} : 1$, just as Eq. (4) implies a relationship for the transition from four to two particles in the ratio $\sqrt[3]{2} : 1$. Charge volume conservation has also been explored in relation to the creation of the $W^{\pm}$ and Z^0 bosons.[14] Note that in these transitions, now to be discussed, the charges are not in close association in the sense of the aggregations considered in Table I. They are close enough to exhibit a charge-paired relationship, but not close enough, even in their clusters, to have interactions effectively changing their collective mass property.

A collective particle transformation is of special interest, where a three-particle cluster (e.g. two positive and one negative charges of like mass) involves pair annihilation with energy transfer elsewhere, followed by local adjustments with numerous other such clusters to conserve both energy and charge volume. The energy/volume ratio is then one-third that of the original particle form. From the Thomson formula (1) this implies that the charge radius (inversely proportional to energy) has decreased by the factor $\sqrt[4]{3}$. Such a process can occur in reverse as energy is forced into a particle system. There is an analogous process where pair annihilation occurs in the presence of other similar pairs, which then share the additional space. The factor involved is $\sqrt[4]{2}$. This process, like the previous one, appears reversible. Indeed, the examples to be given relate only to the reverse process, because one of the particles is the proton and we have only evidence of synthesis of more massive particle forms.

These appear as the first two examples in Table II. The remainder of the data in the table show how the simple transformation of a three-particle cluster to or from a single particle at constant volume builds the several hyperons listed. The delta hyperon $\Delta(1235)$ forms the tau $\tau(1782)$, and this has lepton characteristics and can combine with the $Q(211)$ quantum, the energy of two virtual muons, to form a state from which there is decay to the hyperon forms listed. As with the data in Table I, the dimuon unit seems to be a dominant feature.

It is submitted that these quite simple connected mass relationships are significant, especially when considered alongside the data in Table I and the data given in Ref. 10. However, before concluding, there is one further surprise from this analysis. The 2.587-GeV graviton, which is basic to Eq. (3) and the particle synthesis in Table I, can actually be deduced by extrapolation from Table II.

TABLE II

Hyperon	Process	Energy (MeV)
$\Lambda^0(1115)$	$\sqrt[4]{2}(P)$	1116
$\Delta(1235)$	$\sqrt[4]{3}(P)$	1235
$\Sigma^*(1385)$	$(\tau + Q)/(\sqrt[3]{3})$	1381
$\Xi^*(1530)$	$(\tau + 2Q)/(\sqrt[3]{3})$	1528
$\Omega^-(1675)$	$(\tau + 3Q)/(\sqrt[3]{3})$	1674
$\tau(1782)$	$\sqrt[3]{3}(\Delta)$	1781

The dominant role which this hidden particle state $g(2587)$ asserts means that it is either a lepton or quasistable, because its presence is needed to sustain gravitational action. The action appears to involve a triple particle cluster in which three g particles degenerate to the form g^+, τ^-, τ^- or g^-, τ^+, τ^+, so that pair annihilation cannot readily occur, and the residual three particle cluster is therefore a quasistable system. As with the process already discussed, this will have the energy/volume ratio one-third that of the original g-particle. The action is a collective action involving adjustment by pair creation and annihilation between clusters until this equilibrium state is achieved. This gravitation theme provides a clear role for the tau lepton.

The energy-volume compatibility requirement then tells us that

$$\frac{g + 2\tau}{1/g^3 + 2/\tau^3} = \frac{g}{3(1/g)^3}, \tag{6}$$

where the symbols denote energies. Note again that the radius of the particle is inversely related to the energy by the Thomson formula, so that $(1/g)^3$, for example, is a measure of the volume occupied by the g particle. Rearranged, (6) becomes

$$\left(\frac{g}{\tau}\right)^3 - 3\frac{\tau}{g} - 1 = 0, \tag{7}$$

which has a solution $g = 1.452627\tau$. Now, had we taken the combination of energy $\tau + 4Q$, which is the next stage for building energy quanta from a tau lepton and four muon pairs, we would have arrived at the energy 1781 + 4(211) = 2625 MeV. This could decay into a 1820-MeV particle by the process described, involving reduction by the factor $\sqrt[3]{3}$. However, instead, it seems that, because we have exceeded the value needed to create the g particle, pairs of such particles are likely to be created in the chaotic energy processes involved. Then decay should proceed via Eq. (7) as the tau leptons are reconstituted.

The point, however, is that the solution $g = 1.452627\tau$ tells us that the g particle has a mass-energy of 2587 MeV, which is exactly that expected from the empirical data leading us to Table I. Indeed, because we have calculated the tau mass-energy as $3^{7/12}$ times that of the proton (P) via the data in Table II, we can determine the mass of the g particle with the same precision as the mass of the proton. The proton/electron mass ratio is 1836.1524, and when this is multiplied by $3^{7/12}$ and by 1.452627, we obtain 5062.716. This is the value of g for use in Eq. (3), and it may be verified as giving G as 6.67×10^{-11} N m^2 kg^{-2}, in accord with its measured value.

Precise evaluation of G from this theory requires an adjustment to Eq. (3) to allow for the fact that the analysis is based on a point charge assumption. For the record, this correction is the term ϵ included in the tabulated data in Table I of a paper by Eagles.[15] The correction to Eq. (3) is the factor $1 + \epsilon$, where ε is calculable as 1.98×10^{-4}. Thus, the rigorous calculation of G based on the particle theory presented in this work gives a value of 6.6705×10^{-11} N m^2 kg^{-2}.

Such analysis convinces the author that the 2.587-GeV particle is a major constituent of the particle spectrum that has somehow eluded us. It is seemingly hidden in the space metric, where it plays its role with the tau lepton in regulating gravitation. The one direct indication which the author has seen arises from the likely possibility that the decay of the tau and the decay of the g particle may be associated. The tau lepton has a lifetime of the order of 4.6×10^{-13} s and falls in a class of particles discussed by Prentice[16] as "in the 10^{-13} s range." One such reported decay time was 10.69×10^{-13} s for the "longest lived entry... giving a fitted mass of 2583 ± 26 MeV/c^2... ." This might be direct evidence of the $g(2587)$ particle.

In conclusion, the author notes that the theory from which Eq. (3) was formulated was developed essentially in order to account for the nature of the photon and gave a calculated value of the fine-structure constant in close accord with the observed value. See the review, making comparison with other theories, by Eagles[15] and Petley.[17] The derivation of the constant of gravitation emerged directly in qualitative terms because it was a characteristic of the space metric set in balance with the motion of matter in the oscillations at the Compton electron frequency that were basic to the energy–angular-momentum relationships leading to the photon formulation. The problem was that quantitative formulation of G depended upon the knowledge of the g particle which provided this balance. Its energy state could be calculated in terms of G, and efforts were made to explain how it might be created with its energy at 2587 MeV. However, it is only now, in this paper, that this energy quantity has emerged naturally from analysis of hyperon energy states. The progress reported in this paper should therefore allow a definitive theory of quantum gravitation to be formulated, which has the attraction of allowing G to be theoretically determined by a process related to the theoretical determination of the fine-structure constant.

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