A Theory of Pion Creation

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Abstract

Pion creation is discussed using the same physical principles as those involved in a recent paper [Phys. Essays 1, 72 (1988)] on proton creation. The proton-electron mass ratio was deduced theoretically with part per million concordance with its measured value. Now it is shown that the theory for the charged pion gives a pion/electron mass ratio also in precise accord with its measured value. Other meson creation is discussed and particularly the neutral pion, which is dependent upon resonant interactions that account for its lifetime and mass in a way that supports the proton creation theory.

Key words: hadron mass, protons, pions, pion lifetime

1. INTRODUCTION

In a recent paper[1] the author has shown how the proton can be created from a concentrated muon field. This was subject to threshold conditions that applied in an earlier epoch before what may be considered a state of saturated equilibrium of the vacuum field was reached.

The paper derives, with part per million precision, the measured proton/electron mass ratio using techniques that are simply based upon coulomb interaction energy and a finite charge form specified by a formula used by Thomson. This formula merely requires the energy E of a charge e bounded by a characteristic sphere of radius r to be given by

$$E = 2e^2/3r. \tag{1}$$

The author is anxious that this method is not seen as restricted to this one case of the proton. Other particle forms should be predicted if the theory is to have any chance of acceptance and, though the earlier paper did address the derivation of the muon/electron mass ratio, more needs to be offered.

The object of this paper, therefore, is to follow the same argument and present a self-contained account that discusses how both the charged pion and the neutral pion are created and explains their decay and why the pion is such an important by-product of high-energy particle collision.

Though self-contained, the argument used makes no reference to methods that are familiar to experts in modern hadron physics. The reason for this is twofold. Firstly, the reported progress on the conventional front, which builds on QCD (quantum chromodynamics), is, at this time, far away from giving representative values of pion mass and pion lifetimes, as related to the properties of the electron. Secondly, QCD is a cumbersome theory, which is structured on a four-space model required by relativity, and neither QCD nor the theory of relativity has proved itself by yielding any precision values of dimensionless physical constants. The weakness of QCD is that it is expected that such data (e.g., for the proton-electron mass ratio or the pion-electron mass ratio) should be forthcoming from the exhaustive calculations being performed, but the task is proving elusive. The variable parameters in the mathematical analysis are constantly being restructured in a seeming trial and error fashion in order to arrive at what might prove a viable spectrum of particle mass values.

It can also be said that QCD has evolved empirically and has been adapted to suit the classification of known particle properties, without any initial concern with precision mass values. Also, QCD has come to have exclusive rights in the domain of hadron particle theory, being supported to the exclusion of rival theory. Perhaps QCD appears to have intrinsic merit which justifies its sole existence, but as long as it has not yielded the expected answers in explaining what is already known concerning the most basic particles in the hadron mass spectrum, it is still on shaky ground. It is inconceivable to imagine that other theories should not be standing alongside QCD in the testing struggle to get at the real truths of nature. It is also inconceivable to think that any theory that can explain low energy GeV particle mass relationships cannot also predict particle forms or resonances that lie high in the GeV range. Yet, rival theory is not seen as warranting any attention, and unwanted theory predicting numerical quantities that relate to something yet to be discovered is discarded as mere speculation. Therefore, QCD is seen to stand alone and somehow claims the predictive power for the *W* and *Z* bosons, whilst still struggling to explain the proton.

Concerning theory yielding precision values of physical constants, theorists take strength from QED (quantum electrodynamics) which has good support from electron properties. It is argued that QCD is really somewhat analogous to QED and so inferred that similar results for hadrons are to be expected, given enough computational power. However, while that is a hope and QCD is a route to be explored, it is not in the best interests of physics to turn away from the alternative possibilities.

Consider also the fact that neither the theory of relativity nor QCD, nor indeed QED, explains the true nature of the photon. More particularly, they do not offer any route to the theoretical computation of the dimensionless fine-structure constant, which incorporates the Planck quantum of action. Given then that there is a route, involving what this author has termed SLED (synchronous lattice electrodynamics), for the precision determination of the fine-structure constant, there is purpose in following that route to see if it can cast light on the problem of determining the fundamental hadron particle spectrum.

What the author claims is that the SLED method implicit in the photon theory to be referenced later finds direct application in accounting for the proton-electron mass ratio, as already mentioned. Furthermore, the principles extend to other hadron forms. However, the methods are not at all related to QCD and they even find sufficient structure in a three-dimensional space and so do not require formulations necessarily cast in a four-space metric.

It is for this reason that what follows is almost wholly referenced on prior published work of this author, and, unfortunately, this entails new ideas unfamiliar to the reader. This is why, so far as possible, effort has been made to render this text self-sufficient.

2. WAVE NODE RESONANCE

There is one important physical principle which affects the precise determination of pion mass and which was not needed in the discussion of the proton mass determination. It will be seen how the physics used in the proton theory will point directly to a specific particle form that has a mass extremely close to that of the charged pion. However, pions are short-lived particles, and contrary to the situation with the proton, their transient nature in a fluctuating energy field allows them to assume a simple resonant mass state. The charged pion is particularly sensitive to interaction with the electrons in a nearby matter field. The neutral pion has a much shorter lifetime and a dual sensitivity to field resonance, in that it is affected by the presence of electrons and a particle which we will term the "subelectron."

The "subelectron" was not discussed explicitly in the earlier proton paper,[1] but it was implicit in the argument. There was reference in Sec. 5 of that paper to a "degenerate" electron state. That state is what the author refers to as a "subelectron." It is believed to be the primary denizen of the true vacuum. In previous writings the author has usually referred to this as a "lattice particle," because it featured in a structured vacuum state resembling in some respects liquid crystal properties. This subelectron has the property of being activated statistically by multiple muon impact to create the quasi-proton in company with a quasi-electron. The "quasi" term merely means that the creation is abortive in the sense that it is short-lived, so that these created particles have a ghostlike presence, but one which nevertheless can affect other particle creation processes in high-energy matter fields.

The important factor that is brought forward from the proton paper is the N factor, which was shown to be 1843. Earlier joint research with D.M. Eagles gave a less direct justification for this $N = 1843$ factor,[2] compared with the argument summarized in the proton paper.[1] However, for the purpose of this discourse what matters is that the radius of a bounding subelectron sphere corresponds to a volume that is 1843 times that bounding the electron.

By "wave node resonance" we mean a property by which standing wave oscillations on a charge set up discrete nodes and antinodes which have a resonant interaction with similar standing waves on other charges. It appears that such resonance can fine-tune the rest mass-energy of a fundamental particle. Thus, given a valid theory that determines the energy package from which a particle form nucleates, we can appeal to this "wave node resonance" to give us the precise mass value.

By way of example, in the proton paper[1] it was stated by Eq. (10) that the mass of the real muon, as opposed to that of the migrant virtual muons of the vacuum state, has a specifically formulated value in electron units of

$$\mu_{\text{real}} = 209 - (9/4)207/[207 + \sqrt{(3)}]. \tag{2}$$

If this is evaluated it comes to 206.768 670 4, which is nearly two parts in a million higher than the measured value. Now, as was shown in Ref. 5 of the proton paper or in Ref. 3 of this paper, the effect of wave node resonance between the muon and the electron is to cause the $\sqrt{(3)}$ term in the above equation to be replaced by $1 + 2\pi/9$. This involves resonance between surface standing waves on the muon core charge and the standing wave interaction separating the muon core charge and the electron.

When this substitution is made in Eq. (2), the reader may verify that the real muon mass, in terms of the electron, becomes 206.768 307 8. This brings the muon mass into perfect accord with that measured.

For this reason the reader is asked to bear in mind that wave node resonance can also "fine-tune" the mass properties of other short-lived fundamental particles, such as the charged and neutral pions.

What we can expect from such tuning is that charges have an integer numerator and denominator ratio for their mass ratio vis à vis a primary reference charge such as the electron. Charges such as the real muon of which the bounding charge spheres are slightly separated may also have a supplementary resonance ratio applicable to the free-standing waves in the space between adjacent bounding spheres.

3. THE PROTON EQUATION

As was shown in Ref. 1, the proton is the product of a creation process involving muons. If two muons each of energy μ merge to produce a charge of $+e$ of energy 2μ in a coulomb coupling with an opposite charge $-e$ of energy μ, we can have perfect energy balance.

To verify this add 2μ and μ and substract the coulomb interaction energy of the charges. If r is the bounding radius of the μ charge at which it interfaces with the bounding radius of the 2μ charge, we see from Eq. (1) that this latter charge has a bounding radius of $r/2$. The separation distance between the charge centers is $3r/2$. As a result, the coulomb interaction energy is negative and is $2e^2/3r$, which is exactly equal to μ.

The proton equation was developed on the basis that this neutral entity $(2\mu{:}\mu)$ would adjust to shed energy by adopting a minimum value nucleated on the 2μ energy charge. Thus the μ component becomes a degraded charge form denoted ϵ and the energy of $(2\mu{:}\epsilon)$ can be evaluated as $(\sqrt{6} - 3/2)2\mu$. The proton equation was then written as

$$n\mu + (2\mu{:}\epsilon) \rightarrow (P{:}2\mu) + \epsilon \rightleftharpoons P. \tag{3}$$

This gave a unique value for P in terms of μ, by requiring P to be 8.898 979 5 times μ. However, the remarkable factor that explains why the proton is the primary matter form is the fact that there is perfect energy balance when n is the odd integer 7.

The proton equation shows us that P can be a charge system that changes state whilst retaining the same rest-mass energy. It is sometimes a composite of three charged particles, which have the values $+e$, $-e$, and $+e$, but this does not preclude the triple quark state with fractional charge forms $+2e/3$, $+2e/3$, and $-e/3$. The author has reserved his own position on such quarks and developed this theory without any commitment to fractional charge. The reason is that the vacuum properties can intercede in a way that can meet similar criteria, because a neutral state or double-charge state can be a question of whether a $+e$ charge or $-e$ charge is free or takes up a subelectron site in the vacuum lattice. In any event, the quark idea can be interposed in the proton equation, and the author's theory offers an explanation for the proton mass which is exceptional.

When we extend this "mass" determination method to other particles, we are similarly not entering conflict with quark theory, nor shall we get involved in the hierarchical classification of conventional theory or questions of spin properties. This is not necessary for the pion property. The sole objective is, therefore, to examine why pions are such a prevalent particle form and why they have the mass measured. Our hope is that the more prevalent the particle in cosmic rays and in particle physics, the more direct will be its mass derivation from this theory. For this reason, the pion is the first candidate for analysis after the proton and the muon, the electron being assumed as the mass reference.

4. THE PION CREATION PROCESS

It occurred to the author to consider the effect of merging μ with the $(P{:}2\mu)$ neutral "quark" aggregation in the proton equation. The resulting energy is given by $(\sqrt{6} - 3/2)P$ plus μ or, using the P/μ ratio deduced above, $(\sqrt{6} - 3/2)P$ plus $(0.112\,372\,4)P$, which is:

$$(1.061\,862\,2)P. \tag{4}$$

From the proton/electron mass ratio of 1836.1527 this energy is nearly 1950 electron mass units shared by three charge constituents. The step of interest involved considering the energy of a three-charge in-line particle form which can be denoted $(P{:}\pi{:}\pi)$, where π is the energy of the $-e$, $+e$ components of the created charge pair coupled to the proton charge $+e$ of energy P. Here, π is a symbol for the energy of the particle in which we are interested, namely the pion.

A little analysis, working out the energy of P plus 2π adjusted by the three coulomb interaction components, clearly shows that π has about the right energy to be the pion. However, before developing that analysis, we will digress a little to examine how a neutral system can be formed. This would require a charge such as an electron merging with the three-charge system. The resulting neutral complex of four charges, of nearly 1951 times the electron mass can then be investigated from three different aspects.

Firstly, it could split into two equal neutral forms, each comprising two charge components. The mass of each such neutral form would be about 975 e.u. of 0.511 MeV or 498 MeV. This is the mass-energy we associate with the neutral kaon, which is an interesting by-product of this analysis.

Secondly, it could involve two charges annihilating to consolidate the energy into, say, an electron and a unitary charge Z conforming with the Thomson formula (1). The neutral entity $(e{:}Z)$ would, by the resonance criteria discussed above, have Z as an integer in electron units. To correspond with the energy supplied, Z is 1951, and this gives a total energy in electron terms, which is 1952 less the coulomb component $3(1951)/2(1951 + 1)$ or 1950.501, which is

$$(1.062\,276\,0)P. \tag{5}$$

Thirdly, the four-charge neutral entity could form as an in-line system denoted $(\pi{:}P{:}\pi{:}\pi)$, where there are three identical-energy π particle components associated with the proton, placed at an inner position owing to this being a least energy configuration.

The third option appears to be one that forms via the second as an intermediate step, so that the energy given by expression (5) creates $(\pi{:}P{:}\pi{:}\pi)$ with a π/P ratio of 0.148 744 12. This may be verified by analysis using the energy terms $P + 3\pi$ and coulomb interaction terms which together comprise $-3\pi/4 - 9P\pi/4(P + \pi) - 3P\pi/4(2P + \pi) + 3P\pi/2(3P + \pi)$.

Again, however, there is a resonance effect in the $(\pi{:}P{:}\pi{:}\pi)$ system which causes π/P to become an integer ratio that very closely approximates 0.148 744 12. A search for such a ratio depends upon the degree of approximation that nature accepts. However, it is a search that we shall not pursue, because what we are interested in is the value of the pion mass once it is free from the proton complex. Then the pion will be affected more by electron or subelectron interaction.

Note that we have established that π is close to 0.148 744 12 times P, which is 1836.1527 times the electron mass. Therefore, π is close to 273.117 e.u.

We will defer discussion of the regulating wave resonance that fine-tunes the pion mass until we see how π is freed from its proton system.

5. THE PION EQUATIONS

Just as for the proton there is something remarkable about the equations governing pion creation.

What has just been presented shows how we can deduce the pion/electron mass ratio, but this does not tell us why the pion is so special. As we have seen, neutral kaons can also emerge from the type of equation presented.

The remarkable feature is that the $(\pi{:}P{:}\pi{:}\pi)$ system can, in an energetic environment, deploy energy from that environment to shed the isolated π and leave a charged entity $(P{:}\pi{:}\pi)$ which has precisely the amount of energy needed to reconstitute the state which led to $(\pi{:}P{:}\pi{:}\pi)$ being created from an added electron. In other words, the system is an ideal catalyst for converting electrons into pions.

Using the π/P value of 0.148 744 12, which is already deduced, calculation of $(P{:}\pi{:}\pi)$ gives $(1.062\,562\,76)P$. This can be checked from the analysis of $P + 2\pi - 3\pi/4 - 3P\pi/2(P + \pi) + 3P\pi/2(3P + \pi)$. Therefore, when the pion is released from the $(\pi{:}P{:}\pi{:}\pi)$ system we are left with a three-charge unit of energy equal to 1951.027 e.u. This can, therefore, shed a little energy to form the Z charge of 1951 units as before, owing to the resonant interaction with a nearby electron, and stand ready to develop back into the resonant $(\pi{:}P{:}\pi{:}\pi)$ system when that electron comes close enough to merge.

What is so remarkable is the fact that the $(\pi{:}P{:}\pi{:}\pi)$ system, the $(P{:}\pi{:}\pi)$ system, and the $(P{:}2\mu) + \mu$ system all have virtually the same energy. This is an unavoidable fact of physics that could never have been imagined by mere theorizing. Nature has exploited this natural coincidence. The proton and electron are the matter forms favored by nature, but faced with the unique particle systhesis conditions associated with the pion, nature inevitably created pions as well. This is what makes the pion so special and why the pion appears so readily in collisions involving proton and baryon decay.

The pion equations are simply:

$$(P{:}2\mu) + \mu \rightarrow (P{:}\pi{:}\pi); \tag{6}$$

$$(P{:}\pi{:}\pi) + e \rightarrow (e{:}P{:}\pi{:}\pi); \tag{7}$$

$$(e{:}\pi{:}P{:}\pi) \rightleftarrows (\pi{:}P{:}\pi{:}\pi); \tag{8}$$

$$E + (\pi{:}P{:}\pi{:}\pi) \rightarrow \pi + (P{:}\pi{:}\pi). \tag{9}$$

Equation (6) is intimately associated with the processes of proton creation discussed in Ref. 1. Equation (7) suggests that an electron (or positron) is involved in the synthesis of the pion system. Equation (8) is the stage in which the energy equilibrium applies as the electron is converted into a pion. The process in Eq. (9) shows how the pion is liberated to reconstitute the catalyst that recycles to Eq. (7).

6. THE PION MASS

The question at issue now is how the free pion is affected by resonant interaction with the electron-positron fields that are present in this situation. Note that positive or negative pions π develop from positive or negative electrons e. There is an optimum pion resonance state that can then be induced close to the π mass value of 273.117 e.u.

This is one that admits, on a time average, that the pion preserves some characteristic betraying its origin from the electron or positron. The charged pion is seen, therefore, as having a quasi-stable form denoted $(\pi{:}e{:}e)$ for half the time and the isolated π form for the other half of the time. This means that it spends half the time in close company with a coupled electron-positron pair. Similar theory applies in the real muon model of Ref. 3.

Note that in the energy calculation using the Thomson formula and coulomb interaction, e can be written as 1 and π will be written as 273 to exploit the integer resonance condition. Then $(\pi{:}e{:}e)$ mass-energy is then $\pi + 2 - 3\pi/2(\pi + 1) - 3/2(2) + 3\pi/2(3\pi + 1)$, which, with π as 273, is 273.254 864. This mass-energy applies for 50 percent of the time and the bare π of 273 applies for the other 50 percent of the time. This is due to vacuum energy fluctuations associated with the cyclic creation and annihilation of the electron-positron pair.

On this basis the free pion-electron mass ratio is 273.127 432, which is 139.567 8 MeV. This compares with the Particle Data Group listed measurement of 139.568 5 $\pm$0.0010 MeV and so is well within the single standard deviation.

The nonresonant estimate of the π value of 273.117 was equivalent to 139.562 5 MeV, which is in error by six standard deviations.

For this reason the author feels that this is a case where resonance with an electron state is occurring. Moreoever, a pion can decay into a muon, which in turn decays into an electron or positron. This suggests that there is mean presence of a characterizing half of the electron-positron pair, meaning the cyclic 50 percent periods of pair annihilation and recreation. However, it is inappropriate to speculate further on this aspect in this work, though it is relevant to the gravitational implications of the theory and the extension of the theory to the wider meson spectrum.

7. RELATED MESON PRODUCTION

The following equations, which have already been presented elsewhere,[4] will serve to summarize how the principles discussed in this paper can lead directly to other varieties of meson creation:

$$(P{:}2\mu) + e \rightarrow K^*(892); \tag{10}$$

$$(P{:}2\mu) + \mu \rightarrow \omega(783) + (2\mu{:}\mu); \tag{11}$$

$$(P{:}2\mu) + \mu + \mu \rightarrow \eta^o(549) + \eta^o(549); \tag{12}$$

$$(P{:}2\mu) + \mu + \mu + \mu \rightarrow P + \pi^o(135) + \pi^o(135). \tag{13}$$

The first three of these processes suggest that protons can, in fact, decay by degenerating from their transient state in association with the dimuon unit 2μ. However, their decay products do eventually find their way into radiant energy, muons, and neutrinos, and it is conceivable that some regeneration of protons does occur by the vacuum maintaining its equilibrium state.

Note also, from Eq. (6), that the $(P{:}2\mu) + \mu$ component of Eqs. (11), (12), and (13) can be simply the presence of a $(P{:}\pi{:}\pi)$ system.

As then reformulated, Eq. (13) becomes

$$(P{:}\pi{:}\pi) + \mu + \mu \rightarrow P + 2\pi^o. \tag{14}$$

This, together with the pion equations above, shows that in the energetic systems where protons exist and also baryons which decay into protons, there should be a prolific presence of charged or neutral pions in the decay products.

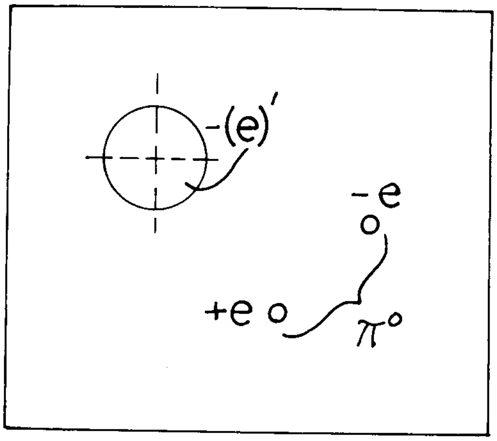
The connection of the pion and these other meson states with the processes involved in proton creation, as discussed in Ref. 1, does therefore open up channels for scientific exploration which were hitherto out of sight.

8. THE NEUTRAL PION

Equation (13) or (14) allows us to estimate the mass of the neutral pion. It is slightly below the measured value if the μ terms are the virtual muons of this theory, of mass $[\sqrt{(3/8)} - 1/2]P$, and slightly above the measured value if the μ terms could involve real muons.

This, however, is a case where the wave node resonance may be relevant. The question, however, is whether the resonance relates solely to the influence of electrons. Here, we must be guided by the decay properties of the neutral pion. The decay does not involve muons or electrons but merely gamma radiation. To the author, this signifies that the neutral pion is resonantly coupled with the degenerate subelectron state of the vacuum medium, as discussed above.

For this reason, the author chose to examine the wave resonance and integer relationships applicable between a charged constituent of the neutral pion and the degenerate electron state. The latter has an effective energy in



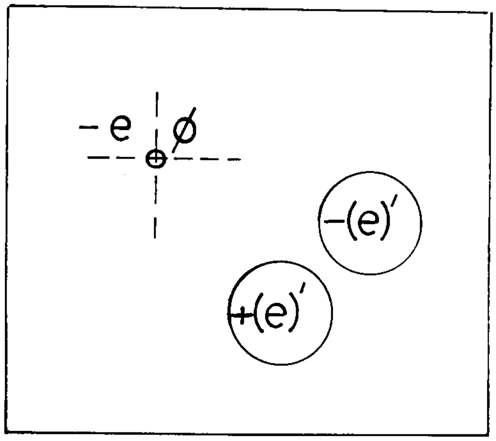


Figure 1 (left). Neutral pion state A. Figure 2. Neutral pion state B.

electron units which is smaller than that of the electron by a factor that is the cube root of N or 1843.

The neutral pion model, envisaged as a charge $+e$ and a charge $-e$, was seen in the following perspective. The pion mass is divided between these two charges set in a vacuum background in which the degenerate subelectron state $(-e)'$ exists in a neutralizing charge continuum of opposite polarity. See Fig. 1.

Sporadically, the energy exchanges between the pion charges in this state A cause one charge to expand into a form which develops a positive version of the degenerate electron state $(+e)'$. This leaves the pion energy concentrated in a negative charge of mass ϕ in electron units. Possibly, this will unseat the $(-e)'$ charge from a vacuum lattice site, denoted by the intersection of the broken lines, and allow ϕ to take this (neutral) equilibrium position. This is then somewhat similar to the Dirac vacuum in which electrons leave vacuum sites to create positive holes or positrons. In this case we are taking out a degenerate electron and substituting the pion to obtain what appears as a neutral system. The two degenerate states $(-e)'$ and $(+e)'$ are shown in Fig. 2.

Now, firstly, it is essential that states A and B prevail for equal periods of time. This assures that the continuum charge displaced by transitions between states averages about a zero mean. Secondly, we note that the "degenerate" subelectron state cannot decay, virtually by definition, because it is the lowest energy state that a negative charge can assume. Therefore, the decay characterizing the neutral pion is the event when the target set by the sphere bounding $(+e)'$ for the migrant virtual muon activity destroys state B. This results in mutual annihilation of $(-e)'$ and $(+e)'$ and leaves ϕ to degenerate directly into the $(-e)'$ state. The decay occurs directly into gamma energy.

Thirdly, we can confirm this by calculating the lifetime involved, because it is known from the proton paper[1] that the degenerate electron form occupies a volume that is one part in $N^{1/3}(2\mu)$ of the cell volume of a migrant muon of opposite polarity. Also, the activating frequency of the vacuum is that of the Compton electron. The state B applies for half the time, so doubling the lifetime otherwise obtained. The reader has simply to multiply the Compton electron period of 8.09×10^{-21} s by the quantity $(4)(1843)^{1/3}(206)$ to obtain

$$\tau = 8.2 \times 10^{-17} \text{ s}. \qquad (15)$$

The Particle Data Group[5] report a measured lifetime of

$$\tau = (8.7 \pm 0.4)10^{-17} \text{ s}, \qquad (16)$$

which supports the theory presented and so helps us in our onward quest to determine the mass of this neutral pion.

The integer correlation involved in the wave node resonance is one that depends upon the degenerate electron state. Now, whatever the resonant mode of interaction between the electron and the degenerate electron in a true vacuum state, we can assume that this adjusts if a third party to the interaction is involved. There are then three interactions that must satisfy the integer connection at the same time.

For this reason we write the inverse-mass ratios of the subelectron, the electron, and the neutral pion ϕ charge as being A:B:C, where A, B, and C are integers.

We know from what has been said about Eq. (14) that the neutral pion has a mass approximately 264 times that of the electron. Thus B/C is approximately 264. Our problem is now to fine-tune this by resonance. We also know that A/B is close to $(1843)^{1/3}$. The mathematical task is, therefore, to step through values of C from unity upwards until we find the optimum resonance conditions.

The mathematics of this exercise involves multiplying C by 264 and the result by $(1843)^{1/3}$ to find, in the first step, an integer B and, in the second step, a nearest integer A. Then A/B is compared with $(1843)^{1/3}$ to determine how close the resonance is in parts per million (δ in the tabulation).

For each C value the analysis must be repeated by stepping the $(264C)$ product either way in integer steps to be sure that the closest resonance is found.

By way of example, Table I gives a typical calculation for $C = 9$.

Table I

C	B	A	δ
9	2375	29 119	+10.1
9	2376	29 131	+1.2
9	2377	29 143	−7.7

The middle term is the one deduced from C times 264 but, to be sure it is the optimum for resonance, the resulting 2376 has been stepped either way to show that adjacent resonance possibilities are not favored owing to the greater discrepancy.

Table II shows the optimum resonance found in this way for C incrementing from unity onwards. In the table it will be seen that two sets of data are given for C as 5. This is because there were two competitive resonance values. What this really meant was that there would be an extremely strong resonance when C was doubled. With $C = 10$ the table shows a truly outstanding resonance condition, which makes it virtually certain that the particle interaction would be regulated to determine mass states in the specified ratios.

Table II

C	B	A	δ
1	265	3249	−10.6
2	530	6498	−10.6
3	791	9698	−33.1
4	1056	12 947	−7.4
5	1320	16 184	+8.0
5	1321	16 196	−8.0
6	1585	19 433	+4.9
7	1847	22 645	−6.9
8	2112	25 894	−7.4
9	2376	29 131	+1.2
10	2641	32 380	−0.004
11	2905	35 617	+6.3
12	3167	38 829	−7.0

Thus, taking the ratio of ϕ mass to electron mass as B/C we know that 264.1 is the optimum ratio. There is then one minute adjustment to this to obtain the proper neutral pion mass as measured. When the system in Fig. 2 decays, there will be a small amount of surplus energy, depending upon how close the two $(-e)'$ and $(+e)'$ charges are positioned. If they are well spaced, this energy will arise from that of one $(e)'$ subelectron, that is the factor B/A in electron units. However, since we must allow for vacuum energy fluctuations to determine the mean surplus energy, this has to be halved owing to state B prevailing for only 50 percent of the time. Therefore, $B/2A$ is an upper limit. The lower limit for this energy surplus is that applicable for touching charge boundaries of the two degenerate states, and this means offsetting the coulomb interaction energy. This reduces the result to $B/8A$, and we should think it more likely that the actual state of the average neutral pion at the time of decay will sit closer to the least energy value.

It follows from this that the upper value of the neutral pion-electron mass ratio is 264.141, but the more representative minimal energy value is 264.110. The theory, therefore, gives us a definite rest-mass energy for the neutral pion of between 134.960 and 134.976 MeV.

This compares with a measured value listed as 134.9642 ± 0.0038 MeV and this is, indeed, in good agreement with the theoretical value.

9. CONCLUSIONS

The object of this paper has been to provide supporting evidence for the proton theory presented in Ref. 1. This has taken the form of an extended analysis showing how the same theoretical principles account for the creation of the charged pion with a mass-energy of 139.568 MeV and the neutral pion with a mass-energy of between 134.960 and 134.976 MeV.

Concerning this charged pion theory, it should also be noted that the author has shown elsewhere[6] how the pion lifetime can be calculated as approximately 26.1 ns. The theory was based on the applicability of Eq. (1) and the statistical encounter with the μ energy quanta on which the above mass calculations are based. The currently listed measured value of this lifetime is 26.030 ± 0.023 ns.

Though this research is based on foundations that have been developing for several years, the author has presented here a novel and original perspective on the physics of particle creation. The approach to calculating the masses of the charged and neutral pions has not been one of manipulation to find the numbers that worked. That in itself is an irrelevant pursuit.

The author sees the precision measurement of the particle masses, and the fact that they are universally fixed with standard precision, as a statement by nature that there are specific controls in nature's fabric setting the mass ratios. Nature has therefore challenged us to solve a riddle to find the basis of that determination of mass. The accuracy with which we can justify the specific mass by physically based argument is an indication of our likelihood of having understood the physics involved. This accounts for the exploration of the resonance possibilities that have been discussed.

It is hoped that the reader will find something intriguing in the concerted action that determines the pion form. The pion equations have a unique characteristic, and the fact that they work so well has to be endorsement for the use of the Thomson formula and the coulomb interaction as governing the particle creation process.

To the author, what is particularly important from the research presented is the new way in which the degenerate electron state manifests itself in the neutral pion situation. That degenerate subelectron state has long been seen by critics of the author's work as a mere hypothesis of an arbitrary vacuum model. Yet it is fundamental to the Plank quantum of action, as readers might appreciate from Ref. 7. That reference gives a self-contained derivation of the formula

$$hc/2\pi e^2 = 108\pi(2B/A)^{1/2}, \qquad (17)$$

which is the reciprocal of the fine-structure constant expressed in terms of the B/A ratio used in this paper. The formula gives 137.036, in full accord with the measured value.

This photon theory is discussed in detail in the paper reported in Ref. 8.

The photon theory is important in that it offers the best possibilities for tests that can verify the principles involved. Since we know the precise value of the proton-electron mass ratio or pion-electron mass ratio, the theoretical derivation of that exact ratio is, for some reason which this author fails to comprehend, generally judged as unimpressive. There is a suspicion that the result is contrived, the intrinsic merit in the analysis seemingly being irrelevant. Concerning the photon, however, or rather its formulation in the fine-structure constant, there is hope that certain minute variations in value will emerge with increasing precision in the tests.

For this reason, the author has shown how certain predicted effects can, if found in future measurement, come to verify the theory involved. This is the basis of the paper in Ref. 9.

Finally, reverting to what QCD has to say about the pion, it is the view of those expert in that subject that the pion has long been recognized as the Goldstone mode of broken chiral symmetry. This has tended to become fundamental to any acceptable theory of hadron physics. Consequently, there is the view that any route in QCD to justifying the origin of pion mass, however partial, would be an important step forward, since it would be dealing with the fundamental questions of the nature of the QCD vacuum and chiral symmetry breaking.

Now, it is conceivable that these words and the terminology of QCD are really speaking about much the same structure as is foreseen by the author's vacuum model. Chiral symmetry breaking is little different from what may be signified by actions involving energy exchanges and state transitions in the ether medium, connected characteristically with the muon field and the dynamic lattice of the author's theory.

However, QCD is far from telling us why the pion has the precise mass listed in particle data, and with the above points in mind, one must wonder how strong QCD really is when one reads the following in an expert treatise on the subject:

> The electroweak theory with which we are now concerned is a chiral theory. For these theories the fermionic integration measure is not in general gauge invariant. In consequence the Shavnov-Taylor identity is violated, and S-matrix elements will be ϵ-dependent, because of the appearance of unphysical particles (e.g. Goldstone scalars) in physical processes. Clearly such a theory is nonsense, the gauge fixing and ghost terms in the Lagrangian were merely technical devices to permit the formulation of quantum field theory, and nothing physical should depend upon ϵ, if the theory is to make sense. Thus the gauge non-invariance of the fermionic measure is a disaster for the chiral gauge theories in which it appears. It means that these theories are non-quantisable. Only theories in which this problem can be evaded can be considered as candidates to describe reality.[10]

It is submitted that the author's theory of the pion does evade the mathematical niceties of the chiral problem completely and so stands a better chance of portraying reality.

It would be inappropriate to end without making reference to a rival theoretical method for deriving basic dimensionless constants, including the proton-electron mass ratio and the fine-structure constant. It is for the reader to compare the techniques involved and judge the relative merits of the arguments used. This also involves radical departure from the conventional QCD methods. This is a reference to a recent paper by Noyes and McGovernan.[11] Concerning the pion, this rival theory is less specific, in quoting the neutral pion-electron mass ratio (measured as just over 264) as approximately twice 137 (or 274), 137 being the reciprocal of the fine-structure constant.

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Résumé

On reprend ici les mêmes principes physiques utilisés dans un travail sur la création de protons, publié recemment [Phys. Essays 1, 72 (1988)] pour traiter la création de pions. Dans ce travail, le rapport de masse entre proton et électron avait été calculé théoriquement et était en accord avec la valeur expérimentale à une part par million. On montre maintenant que la théorie relative aux pions chargés donne un rapport de masse entre pion et électron en tout aussi précis accord avec l'expérience. On discute aussi la création d'autre mésons, et particulièrement la création du pion neutre qui depend d'intéractions résonantes qui expliquent sa durée de vie et sa masse d'une façon qui confirme la théorie sur la création de protons.

References

1. H. Aspden. Phys. Essays **1**, 72 (1988).
2. H. Aspden and D.M. Eagles, Phys. Lett. **41**, 423 (1972).
3. H. Aspden, Lett. Nuovo Cimento **38**, 342 (1983).
4. *Idem*, Hadronic J. **9**, 137 (1986).
5. Particle Data Group, Phys. Lett. B **170**, 1, (1986).
6. H. Aspden, Lett. Nuovo Cimento **33**, 237 (1982).
7. *Ibid.* **40**, 53 (1984).
8. *Idem*, "The Theoretical Nature of the Photon in a Lattice Vacuum" in *Quantum Uncertainties*, edited by W.M. Honig, D.W. Kraft, and E. Panarella (Plenum, NY, 1987) [NATO ASI Series B **162**, 345 (1987)].
9. *Idem*, "Tests of Photon Theory in Terms of Precision Measurement" in *Problems in Quantum Physics; GDANSK '87*, edited by L. Kostro, A. Posiewnik, J. Pykacz, and M. Zukowski (World Scientific, 1988, p. 353.
10. D. Bailin and A. Love, *Introduction to Gauge Field Theory* (Adam Hilger, Bristol, U.K., 1986), p. 273.
11. H.P. Noyes and D.O. McGoveran, "An Essay on Discrete Foundations for Physics," SLAC-PUB-4528, Stanford Linear Accelerator Center (July, 1988) [Phys. Essays **2**, 76 (1989)].

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