A Model of Mesons (Revised)

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Abstract: Detailed models of mesons have been derived in terms of structured particles which can replace the basic quark/anti-quark singularities of standard QCD theory. Pion design is related to the muonic mass, with a Yukawa-type potential for the hadronic field. A charged pion is produced by adding a heavy-electron or positron in a tight orbit around the neutral core. Other mesons are found to be ordered assemblies of pion-size masses, travelling in bound epicyclical orbits, with real intrinsic spin and angular momentum. These orbit dimensions are related to the mean lifetimes of the mesons through action integrals. Decay products resemble components of their parent mesons as expected for a relaxation process with particle traceability.

Key words: meson composite models

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1 Introduction

According to standard QCD theory, mesons have overall finite dimensions yet consist of quark plus anti-quark singularities of infinite mass density. This is mathematically convenient for quantum theory describing *interactions between* particles, but it ignores the reality of complex internal structure.

Comprehension of this analysis requires familiarisation with some concepts developed for previous models of a proton, electron or muon in Wayte, Papers 1, 2, 3, respectively. Those models were successful at explaining potential, the reality of spin and anomalous magnetic moment, and particle creation mechanisms. The conceptual differences between those and the Standard Model can be explained if particles in collisions show behaviour not immediately apparent in static models. That is, the constituents of baryons and mesons need to *behave* like up, down and strange quarks when in collisions.

While high energy collision experiments are theoretically capable of producing a continuum of meson types, it must be significant that so few are chosen to exist. Mesons will be described as complex mechanisms with variation for the different types. In collisions and decay processes, historic traceability of products is considered to be very important as a guide to design. Spin and angular momentum are classical real quantities. Particle mass is simply localised energy travelling at the velocity of light in bound orbits. This energy has left or right screw-like helicity which determines whether the particle behaves as matter or anti-matter. A fundamental particle satisfies the Dirac equation without any concept of negative mass-energy or time-reversal. Real particles satisfy their wavefunction:

$$\Psi = \mathrm{A}e^{\pm i(\mathrm{Et}-\mathrm{px})/\hbar}, \tag{1.0}$$

where +*i* means right-handed helicity and -*i* means left-handed helicity of a circularly polarised wavefunction; and $E,\ t$ are real positive quantities only.

In this static meson model there are indeed two major pieces, but they do not look or behave like QCD quarks, so they will be called *quion* q^+ and *anti-quion* q^- according to their charge sign. These orbit the origin and produce real angular momentum which depends upon their orientation and the orbit radius. Often, there is also an additional particle of zero net spin located at the origin, which increases the mass and adds variety to meson behaviour. We will start with the pion model as the basic design, and then extrapolate to cover other mesons.

The lifetime of a free meson must be a function of its internal design. This inference is based upon analogy with other physical systems; for example when a charged capacitor C is connected to a resistor R, the discharge time constant is determined by the hardware involved (CxR). Separate batches of a given meson type will decay with the same characteristic lifetime; therefore the same mechanism must exist in all batches. The probability that a single meson will decay in any given time increment is a constant, so no ageing occurs. This implies that the smooth-running mechanism is perfect but subject to spontaneous quantum fluctuations of the internal fields which can disturb it catastrophically. Different types of mesons have characteristic lifetimes and mechanisms but there are common features.

The way that the meson's mean lifetime τ and decay width Γ cooperate during its creation in a collision process is interesting. Given:

$$\Gamma\tau \approx \hbar \ , \tag{1.1}$$

the real value of Γ must be established in the short creation period, whereas τ and the decay probability appear realised *after the creation is completed*, over a much longer period in some cases. This contrasts with an atomic emission-line in which the scatter in energy depends upon the lifetime of the excited state *before emission*. Furthermore, the Heisenberg uncertainty principle is written:

$$\Delta E \Delta t \approx \hbar \quad \text{or} \quad \Delta x \Delta p \approx \hbar \ , \tag{1.2}$$

where Δt implies incremental uncertainty in a larger macroscopic value of t; but τ in Eq.(1.1) is the macroscopic value. Effectively, τ is established during the creation stage as a coherence period of a controlling guidewave, (see Paper 1, Section 10.3). The decay probability wavefunction follows as a consequence of this.

Section 2 will now concentrate on the detailed pion design. Section 3 will cover well-observed unflavoured mesons and Section 4 the other unflavoured mesons. Section 5 describes the designs of strange mesons. Section 6 describes aspects of some charmed and bottom mesons and the new particle CERN(125). Section 7 shows how to achieve compatibility with the Standard Model. All particle data have been taken from the Particle Data Group listing at http://pdg.lbl.gov.

2 Pions

$$\pi^o(135): m = 134.9770\text{MeV/c}^2, I^G(J^{PC}) = 1^-(0^{-+})$$

$$\pi^{\pm}(140): m = 139.57061\text{MeV/c}^2, I^G(J^P) = 1^-(0^-)$$

In QCD theory, a pion is thought to consist simply of a quark and anti-quark with net charge determined by the type of quarks. The pion *effective* charge radius has been measured at around 0.659fm, see http://pdg.lbl.gov.

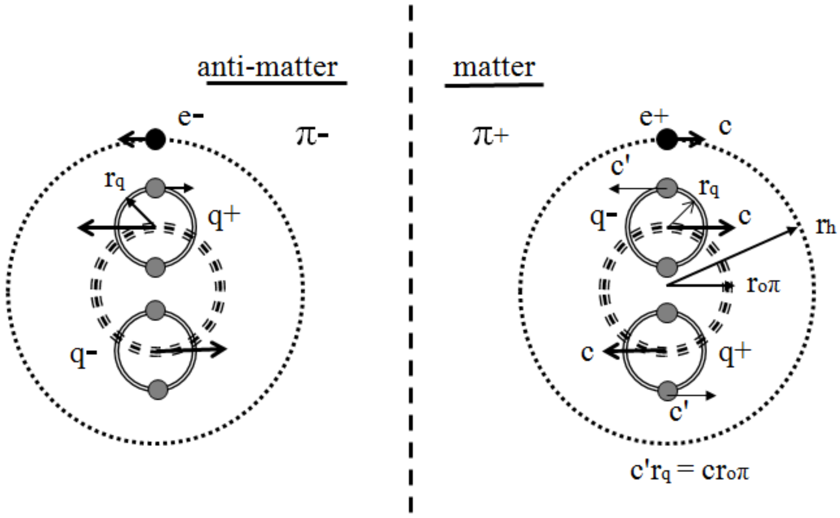


Fig.(2.1) Pion component parts for matter π^+ and anti-matter π^-

Our pion model is illustrated in Figure 2.1, wherein a quion q^+ and anti-quion q^-, each consisting of two smaller pearls, orbit the centre at radius ($r_{o\pi}$) and velocity c to constitute a π^o neutral pion. These may then be orbited at radius (r_h) by a heavy-positron to make a π^+ (classed as matter), or a heavy-electron to make a π^- (anti-matter). In the proton the pearls were equivalent to gluons, so by analogy the quion and anti-quion emit a radial hadronic field in addition to possessing their own native electromagnetic charge plus a gluonic strong colour-field running around their orbit ($2\pi r_{o\pi}$) and their own circumferences ($2\pi r_q$).

Overall angular momentum of the pion is zero because the quions rotate around their own axes counter to their orbital motion, that is:

$$m_q c' r_q = m_q c r_{o\pi} \quad , \qquad (2.1)$$

where $[c' = c(\pi/2)]$, $[r_q = r_{o\pi}(2/\pi)]$, and $[r_{o\pi} = 2e^2/m_{\pi o}c^2]$.

2.1 Yukawa-type potential

The quion /anti-quion pair is proposed to emit an attractive nuclear-type hadronic field similar to the proton; wherein the field-quanta produce a smooth copious field. Published QCD calculations will here be considered unrealistic if the exchange field particles are assumed to be as massive as the source particle. Nevertheless, the calculations may still be useful if aspects like field *range* (r_ℓ) can be re-expressed in terms of our pearl mass ($m_\ell = m_{\pi o}/4$), that is, ($r_\ell = \hbar/ m_\ell c = 5.848$fm).

The metric tensor component for the field is proposed to be analogous to the proton field, (see Paper 1, Eq.(3.5)):

$$\gamma = \left[1 - \left(\frac{r_{o\pi}}{r}\right)\exp - \left(\frac{r - r_{o\pi}}{r_\ell}\right)\right]^{1/2}, \tag{2.2}$$

where ($r_\ell = 5.848$fm) is the range factor, and ($r_{o\pi} = 2e^2/m_{\pi o}c^2 = 2r_\pi/137 = 0.02134$fm) is *double* the pion classical radius because of the quion /anti-quion pair; compare this with positronium. The corresponding empirical potential is given by:

$$V_c = (\gamma - 1)\left(\frac{m_{\pi o}c^2}{a_{\chi\pi}}\right), \tag{2.3}$$

where $a_{\chi\pi}$ represents the hadronic charge for pions, to be determined shortly. Then, from Eqs.(3.8) (3.9) in Paper 1, the hadronic coupling constant for (π-π) is definable as:

$$\chi_\pi = \left[\left(\frac{m_{\pi o}c^2 r_{o\pi}}{2}\right)\exp\left(\frac{r_{o\pi}}{r_\ell}\right)\right]/\hbar c \approx \left(\frac{(1 + 0.5/137)}{137}\right). \tag{2.4a}$$

This hadronic-field is independent of any electromagnetic positive or negative charge which may orbit the hadronic pair. For pion-nucleon interactions it is probable that the coupling constant will be of the order:

$$\chi_{\pi N} = (\chi_N \chi_\pi)^{1/2} \approx (9/137) \approx 0.065, \tag{2.4b}$$

where the nucleon-nucleon coupling constant is $(\chi_N \approx 1/\sqrt{3})$ in Paper 1.

Analogous to the proton derivation, hard-core repulsion will be attributed to rapid spinning of the quion/anti-quion field source which modulates the local hadronic-field and causes it to become repulsive. Here, the source frequency is ($c/2\pi r_{o\pi}$) compared with the Compton frequency of the field-quanta ($c/2\pi r_\ell$).

Therefore, from Eq.(2.2) the full hard-core metric tensor component will be proposed as:

$$\gamma_{hc} = \left\{1 - \left[1 - \left(\frac{r_\ell}{r_{o\pi}}\right)\left(\frac{r_{o\pi}}{r}\right)\exp - \left(\frac{r - r_{o\pi}}{r_{o\pi}}\right)\right] \times \left(\frac{r_{o\pi}}{r}\right)\exp - \left(\frac{r - r_{o\pi}}{r_\ell}\right)\right\}^{1/2} . \quad (2.5)$$

The empirical overall pion potential, as seen by an infinitesimal test charge, is given by:

$$V_{hc} = (\gamma_{hc} - 1)\left(\frac{m_{\pi o} c^2}{a_{\chi\pi}}\right), \quad (2.6)$$

where [$a_{\chi\pi} = (\chi_\pi \hbar c)^{1/2}$]. This potential energy ($a_{\chi\pi}V_{hc}$) as a function of radius is illustrated in Figure 2.2.

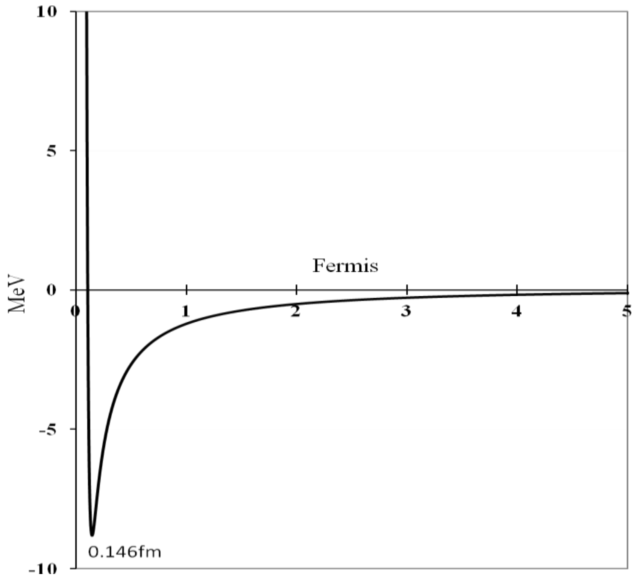


Fig.(2.2) Hadronic potential energy function for the pion.

2.2 Pion mass

The quion /anti-quion masses may be related to electronic mass or to muonic mass as was found for the pearls in a proton:

$$m_{\pi o} = 2m_q = 264.1426 m_e = 134.9770 \pm 0.0005 \ \text{MeV/c}^2, \quad (2.7)$$

and given the muon mass (m_μ = 105.6583745MeV/c^2) we have:

$$m_{\pi o} = 2m_q \approx 2 \times \left\{2\left(\frac{m_\mu}{3}\right)\left(1 - \frac{1}{24}\right)\right\} . \quad (2.8)$$

Here, we recall that a muonic mass consists of 3 distinct packs of core-segments (Paper 3, Eq.(4.2)); consequently each quion pearl here takes the mass of one such pack ($m_\mu/3$), approximately. The small negative term (1/24) in this equation will be taken to express total mass decrement due to binding energy of the attractive field between pearls within the quion itself, plus the binding energy of the quion /anti-quion pair in the pion circumference.

Similar to the proton model, we shall further assume that:

$$\left(1-\frac{1}{24}\right)\equiv\left(1-\frac{r_\ell}{r_q}\right) \quad , \qquad (2.9)$$

where the real quion radius is ($r_q = r_{o\pi}(2/\pi)$), and the pearl radius r_ℓ is thus:

$$r_\ell = \frac{r_q}{24} = \left(\frac{e^2}{m_q c^2}\right)\frac{(2/\pi)}{24} \quad . \qquad (2.10)$$

This implies that a pearl is dimensionally 24 times smaller than the quion, and that there were 24 original pearl-seed particles which subsequently condensed into 2 equal pearls of mass m_ℓ to minimise action /energy, analogous to the 3 pearls in a proton's trineon. It is thought probable that a pearl consists of 24 gluon-loops like a proton pearl. The quion charge *e* was originally divided between the 24 pearl-seeds, thus:

$$\left(\frac{e}{m_q}\right)=\left(\frac{e/24}{m_{\ell s}}\right)=\left(\frac{e/2}{m_\ell}\right) . \qquad (2.11)$$

2.3 Charged pions

A charged pion is produced by adding a heavy-electron or positron to orbit the central quion/anti-quion pair. This increases the total mass, as was found for the neutron in Paper 1, viz:

$$\pi^\pm - \pi^o = 4.5936 \pm 0.0005\text{MeV}/c^2 = 8.9894 m_e = m_h . \qquad (2.12)$$

We shall assume that the mass increase is due solely to the orbiting heavy-electron/positron, with its compressed dimensions. Thus, the classical radius of this heavy-electron is to be equal to the orbit size:

$$r_h = e^2/m_h c^2 = 0.31347\text{fm} . \qquad (2.13)$$

At first sight this result appears arbitrary and does not explain why an electron should attach itself to the hadronic core at all. However, by referring to the neutron analysis, a good physical explanation can be derived. The π^o radius is defined above as $(r_{o\pi} = 2e^2 / m_{\pi o}c^2 = 0.021337\text{fm})$, consequently Eq.(2.13) gives $(r_h = 14.692 \times r_{o\pi})$. Then this ratio of radii must govern a special relationship because the neutral π^o and heavy-electron cooperate to produce a *more stable charged pion*. Consequently, it is proposed that spiralling electromagnetic feeler guidewaves are emitted by the charged quion and anti-quion to communicate attractively and continuously with the heavy-electron/positron. An action equation for these guidewaves will be based upon the following formula:

$$\ln(r_h / r_{o\pi}) = \ln 14.692 \approx \pi(e_n / \pi) \quad . \tag{2.14}$$

This may be differentiated and reduced to an electromagnetic action integral upon multiplying through by $(2e^2 / c = m_{\pi o}cr_{o\pi})$:

$$\left(\frac{\pi}{e_n}\right) \times \int_{2\pi r_{o\pi}}^{2\pi r_h} \frac{2 \times \delta(e^2)}{z} dt \approx \int_0^{2\pi} \frac{\delta(m_{\pi o})}{2} cr_{o\pi} d\theta , \tag{2.15}$$

where δ may be a small fraction. On the left is potential energy action for the feeler guidewave spiralling *out and back* from the quion and anti-quion, with ($z = ct = 2\pi r$) and including a contribution from the gluon energy through factor (π/e_n). On the right is kinetic energy action for the element of pion core material ($\delta m_{\pi o}$) which constitutes the guidewave energy.

Finally, the manner in which the free electron (or positron) is compressed onto the π^o core is interesting. First let the free electron spin-loop be compressed down to standard electron core radius ($r_{oe} = e^2/m_e c^2$) then further to ($r_{he} = r_{oe} /2.843$), as was calculated for the neutron's electron, (see Paper 1). This is followed by compression by factor ($r_{he} /r_h = 3.1619$) to get to the final radius r_h. Then the logarithm ($\ln(r_{he} /r_h) \approx \pi/e_n$) may be reduced to an action integral by differentiation and applying Eq.(2.13):

$$-\int_{2\pi r_{he}}^{2\pi r_h} \left(\frac{e^2}{z}\right) dt \approx \int_0^{2\pi} \frac{m_h}{2} cr_h \left(\frac{1}{e_n}\right) d\theta \ . \tag{2.16}$$

On the left is action due to potential energy of the collapsing electron charge spiral ($z = 2\pi r$), rotating at velocity c. The right side represents action of kinetic energy around the final loop ($2\pi r_h$) for a second harmonic material helix.

2.4 Pion mean lifetimes

It has been shown previously that the lifetime of a neutron or muon may be related to its internal period, by way of an action integral. Similarly, the pion lifetimes appear to be definite functions of internal periods, as follows:

(a) Let the π^o lifetime ($\tau_{\pi o} = 8.52 \pm 0.06 \times 10^{-17}$s) represent a number $N_{\pi q}$ of quion periods, ($2\pi r_q /c' = 1.81 \times 10^{-25}$s):

$$N_{\pi q} = \tau_{\pi o} / \left(2\pi r_q / c'\right) = 4.70 \times 10^8 . \qquad (2.17)$$

Then logarithm ($\ln N_{\pi q} \approx 2\pi^2$) will be taken to indicate that there exists an action integral which will describe the pion structure creation. Thus, after differentiating and multiplying through by ($e^2/c = m_{\pi o} c r_{o\pi} /2 = 2 m_q c' r_q /2$), we get:

$$\int_{(2\pi r_q)}^{N_{\pi q}(2\pi r_q)} \left(\frac{1}{2}\right)\left(\frac{(e/2)^2}{z'}\right) dt \approx \int_0^{2\pi} \left(\frac{m_\ell}{2}\right) c' r_q d\theta \ . \qquad (2.18)$$

On the left, pearl charge is (e/2) and the integral represents classical potential energy action required to create a pearl travelling around a quion loop, by assembly of charge from the guidewave coherence distance $N_{\pi q}(2\pi r_q)$. Alternatively, Eq.(2.18) could represent controlled disintegration of a pearl. Either way, this classical viewpoint allows visualisation and conservation of energy and action. Distance ($z' = c't$) employs velocity [$c' = c(\pi/2)$] for the process. The right side represents kinetic energy action of one *pearl* as it travels at velocity c' over one quion revolution $2\pi r_q$. Only mass ($m_\ell/2$) is involved because half of the mass is in the external field.

(b) The π^+ lifetime ($\tau_{\pi +} = 2.6033 \times 10^{-8}$ s) may also represent a number $N_{\pi +}$ of quion periods:

$$N_{\pi +} = (\tau_{\pi +}) / \left(2\pi r_q / c'\right) = 1.437 \times 10^{17} . \qquad (2.19)$$

Then logarithm ($\ln N_{\pi +} \approx 4\pi^2$) may be developed into an action integral similar to Eq.(2.18), but with double the action now expressed in terms of the quion kinetic energy action:

$$\int_{(2\pi r_q)}^{N_{\pi +}(2\pi r_q)} \left(\frac{1}{2}\right)\left(\frac{(e/2)^2}{z'}\right) dt \approx \int_0^{2\pi} \left(\frac{m_q}{2}\right) c' r_q d\theta \ . \qquad (2.20)$$

Alternatively, the π^+ lifetime could be attributed to the heavy-positron orbit period ($2\pi r_h$ /c), in a manner as follows. Let

$$N_P = (\tau_{\pi+})/(2\pi r_h / c) = 3.963\times10^{15} \ , \qquad (2.21a)$$

then

$$\ln(N_P) \approx 2\pi(137/24) \quad . \qquad (2.21b)$$

Upon differentiating and multiplying through by ($e^2/c = m_{\pi o} c r_{o\pi} /2$), this expression could represent an action integral, such as:

$$\left(\frac{1}{137}\right)\int_{2\pi r_h}^{N_P(2\pi r_h)}\left(\frac{1}{2}\right)\left(\frac{e^2}{z}\right)dt \approx \left(\frac{1}{24}\right)\int_0^{2\pi}\left(\frac{m_q}{2}\right)cr_{o\pi}d\theta \quad . \qquad (2.22)$$

On the left is potential energy action required to establish/dissipate one of the 137 pearls (see Paper 2) within the orbiting heavy positron, operating over guidewave coherence distance $N_P(2\pi r_h)$ at velocity c for lifetime $\tau_{\pi+}$. On the right side is a quantity of kinetic energy action due to one of the 24 pearl-seeds per quion over a pion period. This expression appears to relate the orbiting positron's mechanism to the pion's existing mechanism through some spiralling feeler guidewave link. It is this physical linkage, plus that described in Eq.(2.15), which could then govern the long decay lifetime until guidewave coherence is broken by the internal random quantum fluctuations.

3 Various light unflavoured mesons

Design structures for a few light mesons will now be outlined, using concepts developed for models of the pion, proton and neutron. The decay products can retain some features from their parent and are simpler in design, as would be expected from a self-controlled relaxation process.

3.1 Some J = 0 mesons

3.1a Eta-meson: $\eta(548)$: m = 547.862MeV/c^2, $I^G(J^{PC}) = 0^+(0^{-+})$.

The lowest η-meson has the mass of around 4 pions, and is thought to take the basic design of a pion, see Figure 3.1a. Here the positive quion consists of 2 pearls of approximately pionic mass each; likewise for the negative anti-quion. Analogous to Eqs.(2.7)(2.8), we have:

$$m_\eta = 2m_q = 547.862 \pm 0.12\ \mathrm{MeV/c}^2 \quad , \tag{3.1.1a}$$

and approximate quion mass

$$m_q \approx 2\left[m_\mu^/ \left(1 - \frac{1}{37.7}\right)\right] \quad , \tag{3.1.1b}$$

where ($m_\mu' = 4m_\mu /3$) will be called a *muonet* like a miniaturised muon to be used frequently later. This reveals an overall binding mass decrement due to an attractive field inside the meson. Particle core radius is given by:

$$r_{o\eta} = 2(e^2 / m_\eta c^2) = 5.257 \times 10^{-3}\,\mathrm{fm} \quad , \tag{3.1.2a}$$

and quion radius is

$$r_q = r_{o\eta}(2/\pi) \quad . \tag{3.1.2b}$$

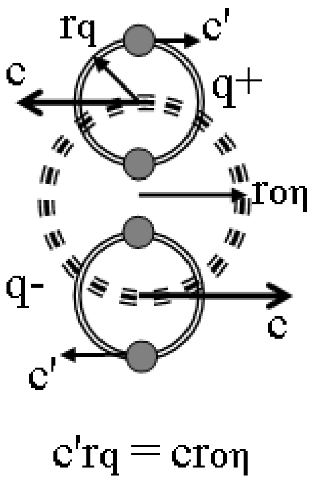


Fig.(3.1a) Component parts for η(548)

Apparently, there were 37 original pearl-seed particles, and the pearl radius is 37.7 times less than the quion radius (r_q):

$$r_\ell = r_q / 37.7 \,. \tag{3.1.3}$$

Although each pearl in a quion has roughly the mass of a pion, it is miniaturised and does not have the same design. The original 37 pearl-seeds in a quion are proposed to have condensed into 2 pearls comprising 37 gluon-loops, each of mass [m_q /(2x37.7)].

If the lifetime of an η-meson ($\tau_\eta = \hbar / \Gamma = 5.063 \times 10^{-19}\,\mathrm{s}$) is related to its core period $(2\pi r_{o\eta} / c = 11.02 \times 10^{-26}\,\mathrm{s})$, then:

$$N_\eta = \tau_\eta /(2\pi r_{o\eta} / c) = 4.59 \times 10^6 , \tag{3.1.4a}$$

and

$$\ln\left(N_\eta\right) = 15.34 \approx \pi^3 / 2 \quad . \tag{3.1.4b}$$

After differentiation, this with Eqs.(3.1.2a,b) can be reduced to an integral representing action of creation (or dissipation):

$$\int_{2\pi r_{o\eta}}^{N_\eta(2\pi r_{o\eta})} \left(\frac{1}{2}\right)\frac{e^2}{z'}dt \approx \int_0^{2\pi}\left(\frac{m_q}{2}\right)c' r_{o\eta} d\theta \quad . \tag{3.1.5}$$

On the left is the amount of potential energy action required to create a quion travelling around the core circumference, by assembly of charge from the guidewave coherence distance $N_\eta(2\pi r_{o\eta})$. Here, (z' = c't = c(π/2) t) may describe an epicycle path, and ($c\tau_\eta$) represent a guidewave coherence length. The integral on the right is a quantity of kinetic action for 2 pearls in a quion travelling at velocity c' in epicycles around one orbit ($2\pi r_{o\eta}$).

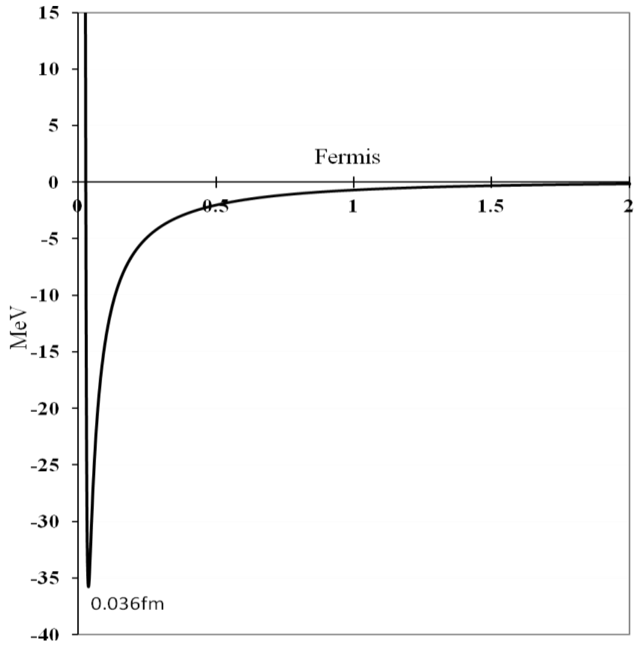


Fig.(3.1b) Hadronic potential energy function for η(548).

An η-meson may emit an attractive hadronic field similar to the pion. The corresponding hard-core metric tensor component is like Eq (2.5), wherein $r_{o\pi}$ is replaced by $r_{o\eta}$. Similarly in Eq (2.6), $m_{\pi o}$ is replaced by m_η and $a_{\chi\pi}$ by ($a_{\chi\eta} = (\chi_\eta \hbar c)^{1/2}$) for (χ_η ≈ (1+0.5/137)/137) derived from Eq.(2.4a) after replacements. Overall empirical potential energy ($a_{\chi\eta}V_{hc}$) as a function of radius is illustrated in Figure 3.1b. It is 4 times deeper in the short range than the pion potential of Figure 2.2. For ηN interactions, the coupling constant will be:

$$\chi_{\eta N} = (\chi_N \chi_\eta)^{1/2} \approx (9/137) \approx 0.065 \ . \qquad (3.1.6)$$

3.1b η'(958): m = 957.78MeV/c^2, I^G(J^{PC}) = 0$^+$(0^{-+})

This eta-meson has a mass of around 7 pions and decays predominantly into η(548) plus $\pi^+\pi^-$ or $\pi^o\pi^o$, which implies that it has a similar but more elaborate design than η(548), see Figure 3.1c. Now, the quions and anti-quion have 3 pearls each, and there is a pearl at the centre.

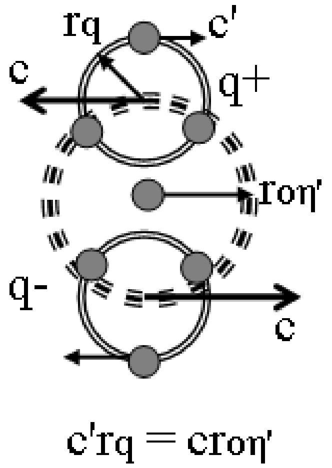


Fig.(3.1c) Component parts for η'(958)

Analogous to Eq.(3.1.1b), let the quion mass be given by:

$$m_q \approx 3\left[m'_\mu\left(1-\frac{1}{37.7}\right)\right] = 3\times 137.140922\mathrm{MeV}/c^2 . \qquad (3.1.7)$$

Factor 37.7 in the denominator means there were originally 37 pearl-seeds, and these condensed into 3 pearls, each comprising 37 gluon-loops. Pearl radius is 37.7 times less than quion radius. Now let the central pearl mass be a little less than a quion pearl mass, in view of its central bound position:

$$m_{c\ell} \approx \left[m'_\mu\left(1-\frac{1}{24}\right)\right] = 135.007913\mathrm{MeV}/c^2 \quad . \qquad (3.1.8)$$

The total meson mass is therefore approximately:

$$m_{\eta'} \approx 2m_q + m_{c\ell} = 957.85\mathrm{MeV}/c^2 \quad . \qquad (3.1.9)$$

Given that the quion's pearls consist of matter, and the anti-quion's pearls of anti-matter, it appears that the central pearl must resemble a pion with its quion and anti-quion components.

Particle core radius $r_{o\eta'}$ is determined by the quion masses *without* the central pearl:

$$r_{o\eta'} = 2(e^2/2m_q c^2) = 3.505\times 10^{-3}\,\mathrm{fm} \quad , \qquad (3.1.10a)$$

and the quion radius is

$$r_q = r_{o\eta'}(2/\pi) \quad . \qquad (3.1.10b)$$

Lifetime is given by $(\tau_{\eta'} = \hbar/\Gamma = 3.26\times 10^{-21}\mathrm{s})$, and may be related to the quion period $(2\pi r_q/c' = 2.97\times 10^{-26}\mathrm{s})$, thus:

$$N_{\eta'} = \tau_{\eta'}/(2\pi r_q/c') = 1.098\times 10^5, \qquad (3.1.11a)$$

and then

$$\ln\left(N_{\eta'}\right) = 11.61 \approx (7/6)\pi^2 \,. \qquad (3.1.11b)$$

After differentiation, this with Eqs.(3.1.10a,b), may be reduced to an integral for action of creation (or dissipation) of the quion/anti-quion plus a central pearl:

$$\int_{2\pi r_q}^{N_{\eta'}(2\pi r_q)} \left(\frac{1}{2}\right)\frac{e^2}{z'}dt \approx \left(\frac{3\frac{1}{2}}{3}\right)\times\int_0^{2\pi}\left(\frac{m_q}{2}\right)c' r_q d\theta \,. \qquad (3.1.12)$$

On the left is potential energy action required to create a quion rotating at velocity c', with (z' = c't) and guidewave coherence distance $N_{\eta'}(2\pi r_q)$. On the right, the integral covers the kinetic action for a quion of 3 pearls rotating at velocity c', plus the action of half the central-pearl.

3.1c $\quad$ a_0(980): m = 980 MeV/c^2, $I^G(J^{PC}) = 1^-(0^{++})$.

The a_0(980) meson has zero spin and mass equal to 8 pions approximately. Since the dominant decay mode is ηπ, it is proposed to have the basic form of η(548), but now with binary pearls, see Figure 3.1d. This produces very strong binding energy within the quion which has mass given by:

$$m_q = \frac{980\mathrm{MeV}/c^2}{2} \approx 4\left[m_\mu^{/}\left(1-\frac{3}{24}\right)\right] \quad . \qquad (3.1.13a)$$

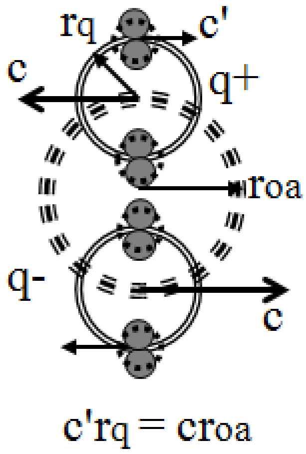


Fig.(3.1d) Component parts for $a_o(980)$

Factor 3/24 signifies binding energy, and (1/24) could be a preferred pearl size relative to a quion. During creation there were probably 24 pearl-seeds, which condensed into the two pearls per quion.

Core radius of the $a_o(980)$ is given by:

$$r_{oa} = 2(e^2/m_a c^2) \quad , \tag{3.1.13b}$$

and the quion radius is,

$$r_q = r_{oa}(2/\pi) \quad . \tag{3.1.13c}$$

Lifetime $(\tau_a = \hbar/\Gamma = 8.8\times 10^{-24}\,s)$ appears to be related to the core period ($2\pi r_{oa}/c$ = 6.13×10^{-26}s) rather than the quion period. That is, let

$$N_a = \tau_a/(2\pi r_{oa}/c) = 143, \tag{3.1.14a}$$

and then

$$\ln(N_a) = 4.955 \approx \pi^2/2 \ . \tag{3.1.14b}$$

After differentiation, this with Eq.(3.1.13b) may be reduced to an action equation:

$$\int_{2\pi r_{oa}}^{N_a(2\pi r_{oa})} \left(\frac{1}{2}\right)\frac{e^2}{z}dt = \int_0^{2\pi}\left(\frac{m_q/2}{2}\right)c' r_{oa}\,d\theta \quad . \tag{3.1.15}$$

On the left is potential energy action required to create a quion, where (z = ct). On the right, the integral covers the kinetic action for a binary pearl in a quion, travelling at velocity (c') in an epicycle around the core circumference ($2\pi r_{oa}$).

3.1d $f_o(980)$: m = 990 MeV/c², $I^G(J^{PC}) = 0^+(0^{++})$.

The $f_0(980)$ meson probably has structure very similar to $a_0(980)$, but with the pearls spinning parallel to the core rotation which might increase the overall mass. The dominant decay (ππ) may exclude (η) because of this spin.

3.2 Some mesons with (J = 1)

3.2a Rho-meson ρ(770): m = 775.26 MeV/c², $I^G(J^{PC}) = 1^+(1^{--})$

The ρ(770) meson is distinctly different from the π and η-mesons because of its spin being ($1\hbar$) rather than zero. If, like other particles, only half its mass is contained in the spin-loop and half is field energy which does not rotate, then:

$$(m_\rho / 2) c r_\rho = \hbar \quad . \tag{3.2.1}$$

Spin-loop radius r_ρ is therefore:

$$r_\rho = 2(\hbar / m_\rho c) = 137\,[2(e^2 / m_\rho c^2)] \quad , \tag{3.2.2}$$

which is now 137 times the classical/theoretical radius for a quion/anti-quion pair in rotation. The mass is around that of 6 pions and is thought to take the design of 3 pearls in the quion and 3 in the anti-quion, as shown in Figure 3.2a.

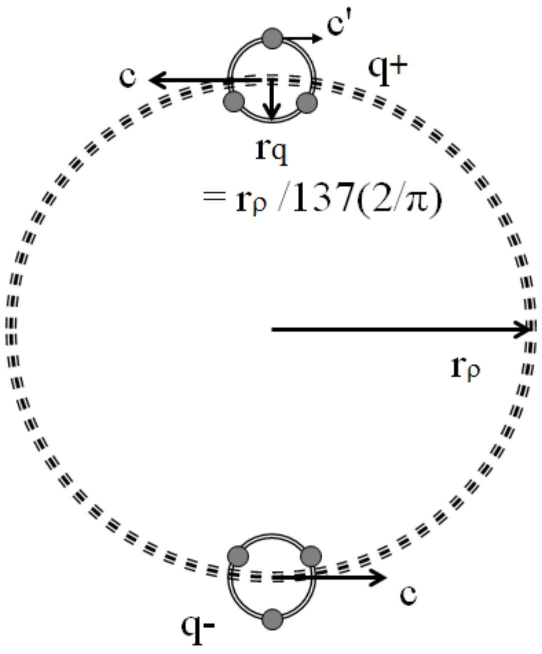


Fig.(3.2a) Component parts for ρ(770)

Therefore:

$$m_q = \frac{775.49 \pm 0.34 \mathrm{MeV}/c^2}{2} \approx 3m_{\pi o}\left(1 - \frac{1}{24}\right) \quad , \qquad (3.2.3)$$

where $m_{\pi o}$ is the "pionet" mass like a miniaturised pion, rather than the muonet mass used previously in Eq.(3.1.1b) etc. As found for the pion pearls in Eq.(2.10), these pearls are smaller than the quion by 24 times. However, the quions are now very much smaller than the spin-loop:

$$r_q = r_\rho / 137(2/\pi) \quad . \qquad (3.2.4)$$

The *electromagnetic* lifetime given by $(\tau_{\rho e} = \hbar / \Gamma_{ee} = 9.35 \times 10^{-20}\,\mathrm{s})$ and the spin period ($2\pi r_\rho /c = 1.0666 \times 10^{-23}$s) may be related by:

$$N_{\rho e} = \tau_{\rho e} /(2\pi r_\rho / c) = 8.77 \times 10^3 \quad , \qquad (3.2.5a)$$

and then

$$\ln\left(N_{\rho e}\right) = 9.079 \approx (\pi/2)(137/24) \quad . \qquad (3.2.5b)$$

This may be reduced to an action integral by differentiating and introducing Eq.(3.2.2):

$$\int_{2\pi r_\rho}^{N_{\rho e}(2\pi r_\rho)} \left(\frac{1}{2}\right)\frac{e^2}{z}dt \approx \left(\frac{1}{24}\right)\left(\frac{1}{2}\right)\int_0^{2\pi}\left(\frac{m_q}{2}\right)c\,r_\rho \frac{d\theta}{2} \quad . \qquad (3.2.6)$$

On the left is the potential energy action required to create (or dissipate) a quion; where (z = ct) over a guidewave coherence length. The integral on the right side represents kinetic energy action of the quion travelling around half the *spin-loop*. Coefficient (1/24) indicates that the quion originally comprised 24 pearl-seeds but the action of only one is considered here. These 24 pearl-seeds formed into the 3 pearls.

The full width (Γ_ρ = 149.1 ± 0.8 MeV) implies a strong lifetime (τ_ρ = 4.406×10^{-24}s) which may be related to the period of the rotating quion ($2\pi r_q /c'$ = 7.783×10^{-26}s):

$$N_{\rho q} = \tau_\rho /(2\pi r_q / c') = 56.6 \quad , \qquad (3.2.7a)$$

and then

$$\ln\left(N_{\rho q}\right) = 4.036 = \pi^4 / 24 \quad . \qquad (3.2.7b)$$

Upon differentiating and applying Eqs.(3.2.2), (3.2.4), this reduces to an interesting action integral:

$$\int_{2\pi r_q}^{N_{\rho q}(2\pi r_q)} \left(\frac{1}{2}\right)\frac{e^2}{z'}dt \approx \left(\frac{1}{2}\right)\int_0^{2\pi}\left(\frac{m_q}{2}\right)c' r_q \frac{d\theta}{3} \quad . \tag{3.2.8}$$

On the left is potential energy action required to create (or dissipate) a quion; where (z' = c't) over the guidewave coherence length $N_{\rho q}(2\pi r_q)$. The integral on the right side represents kinetic energy action of a quion spinning at velocity (c') over one third period ($2\pi r_q$ /3).

3.2b Omega-meson: ω(782): m = 782.65 MeV/c^2, $I^G(J^{PC}) = 0^-(1^{--})$

The ω(782) meson design is similar to ρ(770), see Figure 3.2b, but with a spin-loop radius slightly less:

$$r_\omega = 2(\hbar / m_\omega c) = 137\,[2(e^2 / m_\omega c^2)] \quad , \tag{3.2.9}$$

and a corresponding quion radius

$$r_q = r_\omega / 137(2/\pi) \quad . \tag{3.2.10}$$

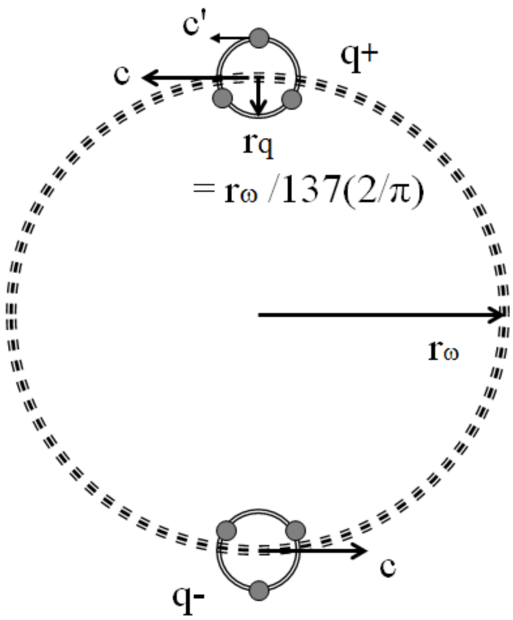


Fig.(3.2b) Component parts for ω(782)

The mass is again around that of 6 pionets, although the binding energy within the quions is less:

$$m_q = \frac{782.65 \pm 0.12\,\text{MeV}/c^2}{2} \approx 3m_{\pi o}\left(1 - \frac{1}{37.7}\right). \tag{3.2.11}$$

Electromagnetic lifetime $(\tau_{\omega e} = \hbar / \Gamma_{ee} = 1.10 \times 10^{-18}\,\mathrm{s})$ appears to be related to the spin period ($2\pi r_\omega /c = 1.056 \times 10^{-23}$s) by:

$$N_{\omega e} = \tau_{\omega e} /(2\pi r_\omega / c) = 1.041 \times 10^5 \quad ; \qquad (3.2.12a)$$

and then

$$\ln\left(N_{\omega e}\right) = 11.55 \approx \pi(137/37.7) \quad . \qquad (3.2.12b)$$

By differentiating and introducing Eq.(3.2.9), this may be reduced to an action integral:

$$\int_{2\pi r_\omega}^{N_{\omega e}(2\pi r_\omega)} \left(\frac{1}{2}\right)\frac{e^2}{z}dt \approx \left(\frac{1}{37.7}\right)\int_0^{2\pi}\left(\frac{m_q}{2}\right)cr_\omega \frac{d\theta}{2} \quad . \qquad (3.2.13)$$

On the left is potential energy action required to create (or dissipate) a quion; where ($z = ct$) over the guidewave coherence length. The integral on the right side represents kinetic energy action of the quion as it travels around half the spin-loop. Factor 37.7 in the denominator implies there were originally 37 pearl-seeds and only one is being considered. These 37 pearl-seeds formed into 3 pearls.

Full width ($\Gamma_\omega = 8.49 \pm 0.08$ MeV) implies a strong lifetime ($\tau_\omega = 7.75 \times 10^{-23}$s), which may be related to one third of a quion's rotation period ($2\pi r_q/3c' = 2.57 \times 10^{-26}$s):

$$N_{\omega q/3} = \tau_\omega /(2\pi r_q / 3c') = 3016 \quad . \qquad (3.2.14a)$$

Then

$$\ln\left(N_{\omega q/3}\right) = 8.01 = \pi^4 /12 \quad , \qquad (3.2.14b)$$

and upon differentiating and introducing Eqs.(3.2.9) and (3.2.10), this reduces to an interesting action integral:

$$\int_{(2\pi r_q/3)}^{N_{\omega q/3}(2\pi r_q/3)} \left(\frac{1}{2}\right)\frac{e^2}{z'}dt \approx \int_0^{2\pi}\left(\frac{m_q}{2}\right)c' r_q \frac{d\theta}{3} \quad . \qquad (3.2.15)$$

On the left is potential energy action required to create (or dissipate) a quion; where ($z' = c't$) over the guidewave coherence length The integral on the right side represents kinetic energy action of a quion spinning at (c') over one third of a revolution ($2\pi r_q/3$); as if a third harmonic guidewave is operating around the quion.

3.2c Phi-meson $\phi(1020)$: m = 1019.461MeV/c^2, $I^G(J^{PC}) = 0^-(1^{--})$.

The $\phi(1020)$ meson has spin $1\hbar$ given by:

$$(m_\phi / 2)cr_\phi = \hbar \quad , \tag{3.2.16}$$

where spin-loop radius is

$$r_\phi = 137[2(e^2 / m_\phi c^2)] \quad , \tag{3.2.17}$$

and quion radius

$$r_q = r_\phi / 137(2/\pi) \quad . \tag{3.2.18}$$

Mass is approximately that of 8 pionets and is to take the form of 4 pearls in the quion and 4 in the antiquion, as shown in Figure 3.2c. During decay these usually convert to separate kaons, although a rho + pi is also possible. Quion mass is given by:

$$m_q = \frac{1019.461\text{MeV}/c^2}{2} \approx 4m_{\pi o}\left(1 - \frac{(4/3)}{24}\right) \quad . \tag{3.2.19}$$

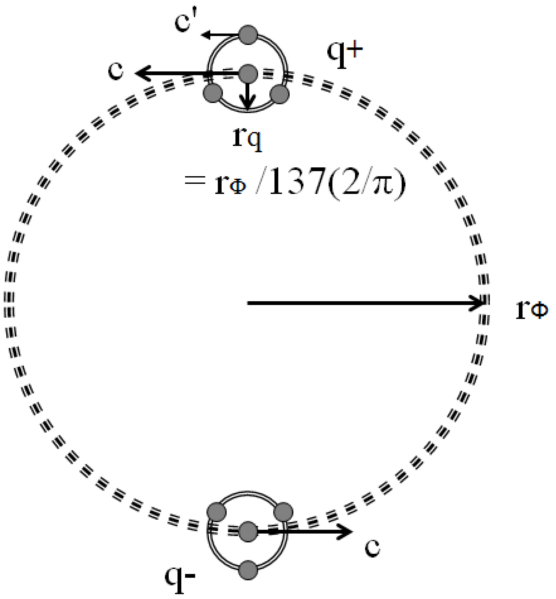


Fig.(3.2c) Component parts for Φ(1020)

The constituent pearls appear to be smaller than the quion by 24 times. Factor (4/3) could indicate that three pearls are at the vertices of an equilateral triangle, and the fourth at the centre, see Simo (1978). Again, the quions are $137(2/\pi)$ times smaller than the spin-loop. This ensures that a quion rotates 137 times at velocity c' during one spin-loop orbit, which is a stable arrangement.

The full width (Γ_ϕ = 4.249 ± 0.013 MeV) implies a strong lifetime of (τ_ϕ = 1.55 $\times 10^{-22}$s), which may be related to the period of the rotating quion ($2\pi r_q$ /c' = 5.921x10^{-26}s):

$$N_\phi = \tau_\phi /(2\pi r_q / c') = 2618\,, \qquad (3.2.22a)$$

and then

$$\ln(N_\phi) = 7.87 = \pi^3 / 4\ . \qquad (3.2.22b)$$

Upon differentiating and introducing Eqs.(3.2.17) and (3.2.18), this reduces to an action integral:

$$\int_{2\pi r_q}^{N_\phi(2\pi r_q)} \left(\frac{1}{2}\right)\frac{e^2}{z}dt \approx \left(\frac{1}{2}\right)\int_0^{2\pi}\left(\frac{m_q}{2}\right)c' r_q d\theta\ . \qquad (3.2.23)$$

On the left is potential energy action expended to create (or dissipate) a quion by assembly of charge from the guidewave coherence length. The integral on the right is kinetic action for the quion pearls travelling at velocity c' around a quion circumference ($2\pi r_q$).

4 General design of light unflavoured mesons

In the previous section, the very lightest mesons have been described in some detail, but more massive mesons of each species have also been studied in order to produce similar viable structures. Choice of design has been based upon the assumption that the decay process is a relaxation effect so that the products should be simpler, but retain some of the parent features. Decays accompanied by low levels of kinetic energy are most likely to satisfy this criterion. Pearls are not created during a decay process, so the number of pearls will either stay the same or decrease. It is easy for the pearl type to either remain unchanged or to lose energy by changing from muonet ($m_{\mu'}$ = 140.8778MeV/c^2) to pionet ($m_{\pi o}$ = 134.9770MeV/c^2); but less easy for the reverse process, except when enough free kinetic energy is accessible. These rules restrict the use of $m_{\mu'}$ to those mesons with [C = +1, (π η a f)], and $m_{\pi o}$ to mesons with [C = −1, (ρ ω φ b h)].

The mesons occupy 8 categories and have been listed with regard to their properties in Table 4.1. They have 5 defining characteristics, $I^G J^{PC}$. Each class has a particular parity P with a free choice of J value, but I, G and C are related through:

$$CG = 1 - 2I\ . \qquad (4.1)$$

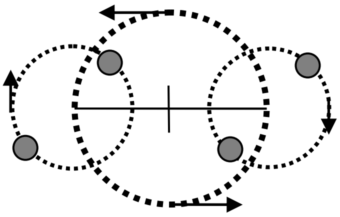
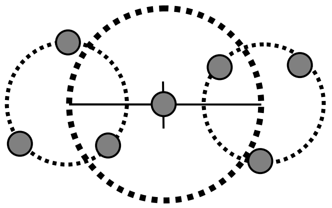
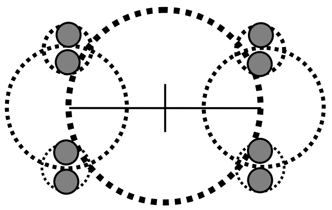
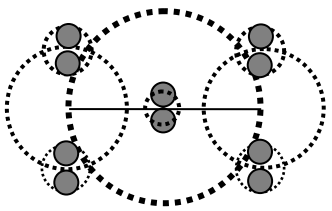
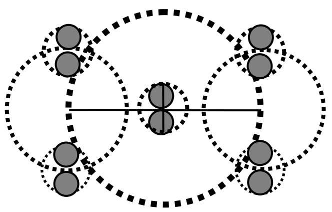
The meson traditional nomenclature is: (a) Pseudoscalar ($J^P = 0^-$). (b) Scalar ($J^P = 0^+$). (c) Pseudovector ($J^P = 1^+$). (d) Vector ($J^P = 1^-$).

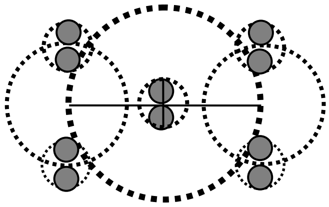
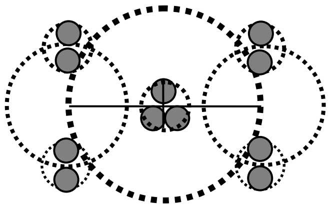
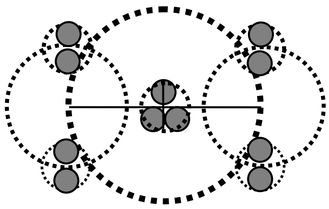
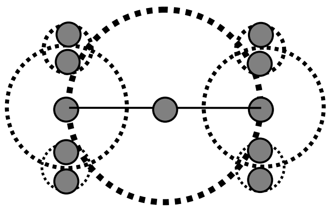
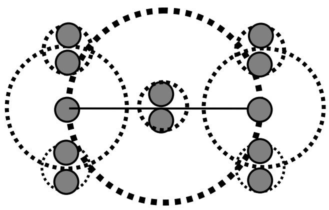
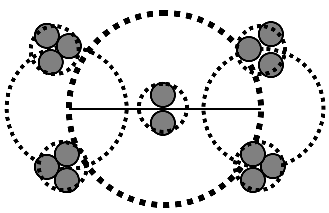
Table 4.1 Classification of the light unflavoured mesons.

	J −+			**J ++**				**J −−**		**J +−**
J^{PC}	**0^{-+}**	**1^{-+}**	**2^{-+}**	**0^{++}**	**1^{++}**	**2^{++}**	**4^{++}**	**1^{--}**	**3^{--}**	**1^{+-}**
I = 1	**G = –1**			**G = –1**				**G = +1**		**G = +1**
	π^o			$a_0(980)$				$\rho(770)$		$b_1(1235)$
	$\pi(1300)$				$a_1(1260)$			$\rho(1450)$		
		$\pi_1(1400)$				$a_2(1320)$			$\rho_3(1690)$	
		$\pi_1(1600)$		$a_0(1450)$				$\rho(1700)$		
			$\pi_2(1670)$		$a_1(1640)$					
	$\pi(1800)$						$a_4(2040)$			
			$\pi_2(1880)$							
I = 0	**G = +1**			**G = +1**				**G = –1**		**G = –1**
	$\eta(548)$			$f_0(980)$				$\omega(782)$		$h_1(1170)$
	$\eta'(958)$					$f_2(1270)$		$\phi(1020)$		
	$\eta(1295)$				$f_1(1285)$			$\omega(1420)$		
	$\eta(1405)$			$f_0(1370)$				$\omega(1650)$		
	$\eta(1475)$				$f_1(1420)$				$\omega_3(1670)$	
			$\eta_2(1645)$	$f_0(1500)$				$\phi(1680)$		
						$f_2'(1525)$			$\phi_3(1850)$	
				$f_0(1710)$						
						$f_2(1950)$				
						$f_2(2010)$				
							$f_4(2050)$			
						$f_2(2300)$				
						$f_2(2340)$				

Scalar and pseudoscalar mesons with zero angular momentum appear to be tight orbiting structures, consisting of discrete pearls of muonet-mass $140.8778/c^2$, and C = +1, see Table 4.2. The quion and anti-quion rotate counter to their orbital motion, in order to cancel angular momentum overall, as in Eq.(2.1) and Section 3.1. All vector and pseudovector mesons ($J \geq 1$) appear to be open structures, to generate the spin, following Eq.(3.2.1). Some of these mesons also consist of $m_\mu{}'$ - pearls, as listed in Table 4.3. The others consist of pearls of pionet-mass ($134.9770 MeV/c^2$), which decay into simpler pionic structures; see Table 4.4.

Table 4.2 Internal designs for scalar and pseudoscalar mesons, comprising pearls of muonet-mass ($m_\mu' = 140.8778 \mathrm{MeV}/c^2$). A proposed mass analysis formula is given, plus $I^G(J^{PC})$, full width Γ, and the main decay products Dy(…).

4μ' 	**η(548) / 547.862 ± 0.024 MeV** $0^+(0^{-+})$, Γ = 1.31keV, Dy(3π,2γ) $\mathbf{m \approx 4m_\mu'\left(1-\frac{1}{37.7}\right)}$ $\mathbf{= 548.56 MeV}$
7μ' 	**η'(958) / 957.78 ± 0.06 MeV** $0^+(0^{-+})$, Γ = 0.202 MeV, Dy(π,η,ρ,ω). $\mathbf{m \approx 6m_\mu'\left(1-\frac{1}{37.7}\right)+m_\mu'\left(1-\frac{1}{24}\right)}$ $\mathbf{= 957.85 MeV}$
8μ' 	**a_0(980) / 980 ± 20 MeV** $1^-(0^{++})$, Γ = 50-100 MeV, Dy(ηπ). **f_0(980) / 990 ± 10 MeV** $0^+(0^{++})$, Γ = 40-100 MeV, Dy(ππ). $\mathbf{m \approx 8m_\mu'\left(1-\frac{3}{24}\right) = 986.1 MeV}$
10μ' 	**η(1295) / 1294 ± 4 MeV** $0^+(0^{-+})$, Γ = 55 MeV, Dy(a_0(980),η). $\mathbf{m \approx 8m_\mu'\left(1-\frac{2}{24}\right)+2m_\mu'\left(1-\frac{2}{24}\right)}$ $\mathbf{= 1291.4 MeV}$
10μ' 	**π(1300) / 1300 ± 100 MeV** $1^-(0^{-+})$, Γ = 200-600 MeV, Dy(ρπ). $\mathbf{m \approx 8m_\mu'\left(1-\frac{2}{24}\right)+2m_\mu'\left(1-\frac{1}{24}\right)}$ $\mathbf{= 1303.1 MeV}$

10μ' 	**f_0(1370) / 1350 ± 150 MeV** $0^+(0^{++})$, Γ = 200-500 MeV, Dy(ππ,ηη,$K\tilde{K}$). $\mathbf{m \approx 8m'_\mu\left(1-\frac{1}{24}\right)+2m'_\mu\left(1-\frac{1}{24}\right)}$ $\mathbf{= 1350.1MeV}$
11μ' 	**η(1405) / 1408.8 ± 2.0 MeV** $0^+(0^{-+})$, Γ = 50.1 MeV, Dy(η,$K\tilde{K}$,a_0(980)). $\mathbf{m \approx 8m'_\mu\left(1-\frac{2}{24}\right)+3m'_\mu\left(1-\frac{3}{24}\right)}$ $\mathbf{= 1402.9MeV}$
11μ' 	**a_0(1450) / 1474 ± 19 MeV** $1^-(0^{++})$, Γ = 265MeV, Dy(η'(958),$K\tilde{K}$) $\mathbf{m \approx 8m'_\mu\left(1-\frac{1}{24}\right)+3m'_\mu\left(1-\frac{2}{24}\right)}$ $\mathbf{= 1467.5MeV}$
11μ' 	**η(1475) / 1475 ± 4 M eV** $0^+(0^{-+})$, Γ = 90 MeV, Dy($K\tilde{K}$π,a_0(980)) $\mathbf{m \approx 10m'_\mu\left(1-\frac{1}{24}\right)+m'_\mu\left(1-\frac{3}{24}\right)}$ $\mathbf{= 1473.3MeV}$
12μ' 	**f_0(1500) / 1506 ± 6 MeV** $0^+(0^{++})$,Γ =112MeV,Dy($K\tilde{K}$,ηη,ηη'(958)) $\mathbf{m \approx 10m'_\mu\left(1-\frac{3}{24}\right)+2m'_\mu\left(1-\frac{1}{24}\right)}$ $\mathbf{= 1502.7MeV}$
14μ' 	**f_0(1710) / 1704 ± 12 MeV** $0^+(0^{++})$, Γ = 123 MeV, Dy($K\tilde{K}$,ηη,ωω) $\mathbf{m \approx 12m'_\mu\left(1-\frac{3}{24}\right)+2m'_\mu\left(1-\frac{3}{24}\right)}$ $\mathbf{= 1725.7MeV}$

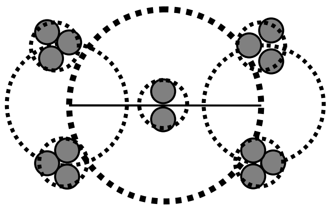
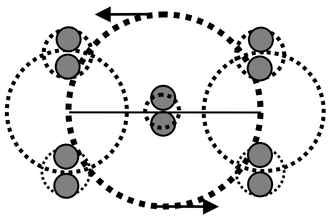
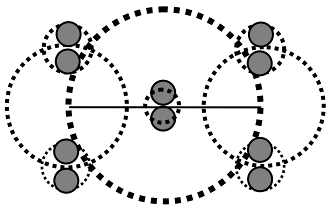
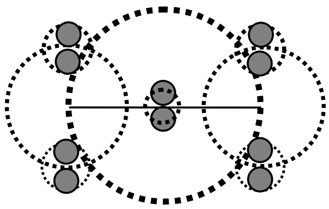
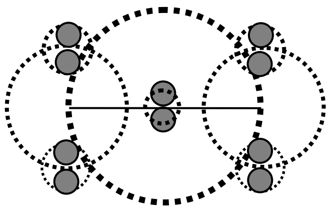
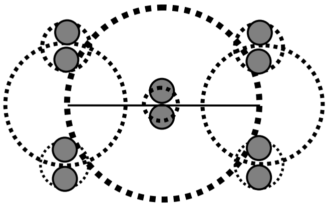
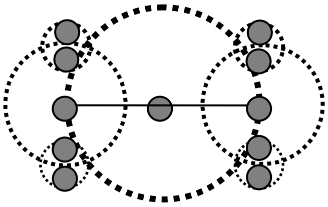
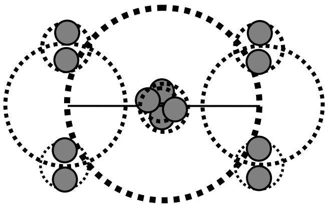
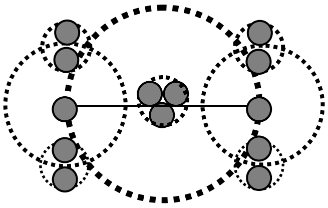
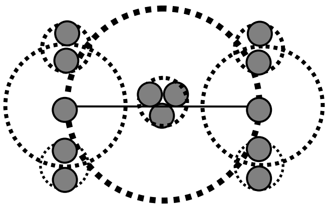
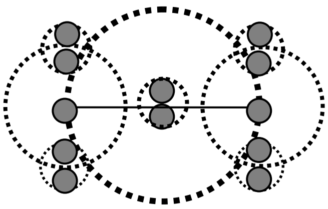
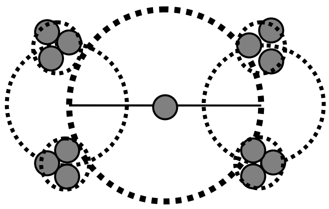
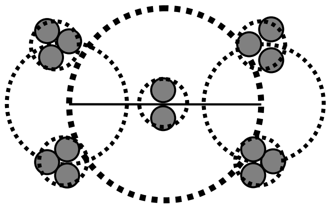
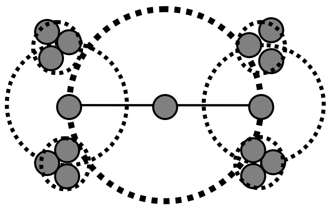
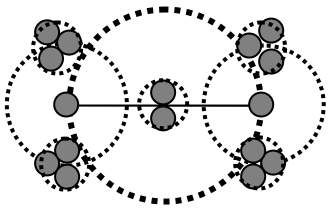
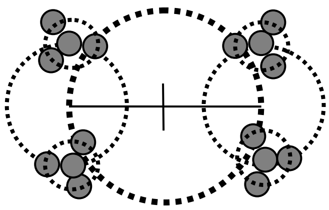
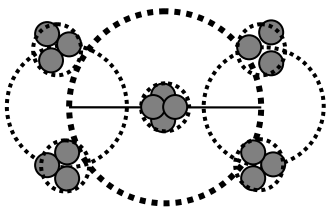
14μ' 	**π(1800) / 1810 ± 11 MeV** $1^-(0^{-+})$, Γ = 215 MeV, Dy($a_0(980)$,ηη'(958)) $\mathbf{m \approx 12m'_\mu\left(1-\frac{2}{24}\right)+2m'_\mu\left(1-\frac{1}{24}\right)}$ $\mathbf{= 1819.7MeV}$

Table 4.3 Internal designs for vector and pseudovector mesons, comprising pearls of muonet-mass ($m_{\mu'}$ = 140.8778MeV).

10μ' 	**a_1(1260) / 1230 ± 40 MeV** $1^-(1^{++})$, Γ = 250-600 MeV, Dy(ρπ). $\mathbf{m \approx 8m'_\mu\left(1-\frac{3}{24}\right)+2m'_\mu\left(1-\frac{3}{24}\right)}$ $\mathbf{= 1232.7MeV}$
10μ' 	**f_2(1270) / 1275.5 ± 1.2 MeV** $0^+(2^{++})$, Γ = 185 MeV, Dy(ππ,K$\tilde{K}$) $\mathbf{m \approx 8m'_\mu\left(1-\frac{2}{24}\right)+2m'_\mu\left(1-\frac{3}{24}\right)}$ $\mathbf{= 1279.6MeV}$
10μ' 	**f_1(1285) / 1281.9± 0.5 MeV** $0^+(1^{++})$, Γ = 22.7 MeV, Dy(ao(980),K$\tilde{K}$) $\mathbf{m \approx 8m'_\mu\left(1-\frac{2}{24}\right)+2m'_\mu\left(1-\frac{3}{24}\right)}$ $\mathbf{= 1279.6MeV}$
10μ' 	**a_2(1320) / 1316.9 ± 0.6 MeV** $1^-(2^{++})$, Γ = 107 MeV, Dy(3π,ηπ,ωππ,K$\tilde{K}$). $\mathbf{m \approx 8m'_\mu\left(1-\frac{1}{24}\right)+2m'_\mu\left(1-\frac{3}{24}\right)}$ $\mathbf{= 1326.6MeV}$

$10\mu'$ 	**π_1(1400) / 1354 ± 25 MeV** $1^-(1^{-+})$, Γ = 313 MeV, Dy($\eta\pi$). $\mathbf{m \approx 8m_\mu^/\left(1-\frac{1}{24}\right)+2m_\mu^/\left(1-\frac{1}{24}\right)}$ $\mathbf{= 1350.1MeV}$
$11\mu'$ 	**f_1(1420) / 1426.3 ± 0.9 MeV** $0^+(1^{++})$, Γ = 54.9 MeV, Dy($K\tilde{K}^*$(892),φ) $\mathbf{m \approx 10m_\mu^/\left(1-\frac{2}{24}\right)+m_\mu^/\left(1-\frac{1}{24}\right)}$ $\mathbf{= 1426.4MeV}$
$12\mu'$ 	**$f_2^/$(1525) / 1525 ± 5 MeV** $0^+(2^{++})$, Γ = 73 MeV, Dy($K\tilde{K}$,$\eta\eta$) $\mathbf{m \approx 8m_\mu^/\left(1-\frac{3}{24}\right)+4m_\mu^/\left(1-\frac{1}{24}\right)}$ $\mathbf{= 1526.2MeV}$
$13\mu'$ 	**π_1(1600) / 1660 ± 15 MeV** $1^-(1^{-+})$, Γ = 257 MeV, Dy($\eta^/$(958)) $\mathbf{m \approx 10m_\mu^/\left(1-\frac{2}{24}\right)+3m_\mu^/\left(1-\frac{3}{24}\right)}$ $\mathbf{= 1661.2MeV}$
$13\mu'$ 	**a_1(1640) / 1655 ± 16 MeV** $1^-(1^{++})$, Γ = 254 MeV, Dy($\pi\pi\pi$, f_2(1270)π) $\mathbf{m \approx 10m_\mu^/\left(1-\frac{2}{24}\right)+3m_\mu^/\left(1-\frac{3}{24}\right)}$ $\mathbf{= 1661.2MeV}$
$12\mu'$ 	**η_2(1645) / 1617 ± 5 MeV** $0^+(2^{-+})$, Γ = 181MeV, Dy(a_2(1320),$K\tilde{K}$,$\eta\pi$) $\mathbf{m \approx 10m_\mu^/\left(1-\frac{1}{24}\right)+2m_\mu^/\left(1-\frac{1}{24}\right)}$ $\mathbf{= 1620.1MeV}$

13μ' 	**π_2(1670) / 1670.6 ± 2.9 MeV** $1^-(2^{-+})$, Γ =259MeV, Dy(f_2(1270),ωρ,K$\tilde{K}$*) $\mathbf{m \approx 12m'_\mu\left(1-\frac{2}{24}\right)+m'_\mu\left(1-\frac{2}{24}\right)}$ $\mathbf{= 1678.8MeV}$
14μ' 	**a_2(1700) / 1705 ± 40 MeV** $1^-(2^{++})$, Γ=258MeV,Dy(ηπ,K$\tilde{K}$,f_2(1270),ωρ) $\mathbf{m \approx 12m'_\mu\left(1-\frac{3}{24}\right)+2m'_\mu\left(1-\frac{3}{24}\right)}$ $\mathbf{= 1725.7MeV}$
15μ' 	**f_2(1950) / 1936 ± 12 MeV** $0^+(2^{++})$, Γ = 464MeV, Dy(K* $\tilde{K}$*(892),ηη) $\mathbf{m \approx 14m'_\mu\left(1-\frac{2}{24}\right)+m'_\mu\left(1-\frac{1}{24}\right)}$ $\mathbf{= 1942.9MeV}$
16μ' 	**a_4(1970) / 1967 ± 16 MeV** $1^-(4^{++})$, Γ = 324MeV, Dy(K$\tilde{K}$,ρω,f_2(1270)) $\mathbf{m \approx 14m'_\mu\left(1-\frac{3}{24}\right)+2m'_\mu\left(1-\frac{3}{24}\right)}$ $\mathbf{= 1972.3MeV}$
16μ' 	**f_2(2010) / 2011 ± 60 MeV** $0^+(2^{++})$, Γ = 202 MeV, Dy(φφ,K$\tilde{K}$) $\mathbf{m \approx 16m'_\mu\left(1-\frac{(4/3)2}{24}\right)}$ $\mathbf{= 2003.6MeV}$
16μ' 	**f_4(2050) / 2018 ± 11 MeV** $0^+(4^{++})$, Γ = 237 MeV, Dy(ππ, K$\tilde{K}$,ηη,ωω) $\mathbf{m \approx 12m'_\mu\left(1-\frac{3}{24}\right)+4m'_\mu\left(1-\frac{1}{24}\right)}$ $\mathbf{= 2019.2MeV}$

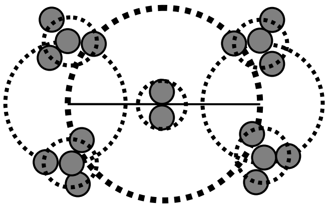
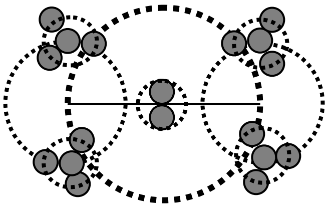
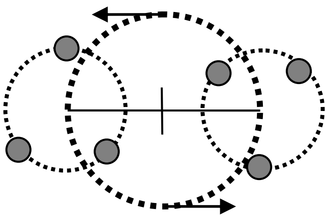
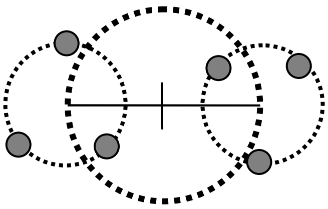
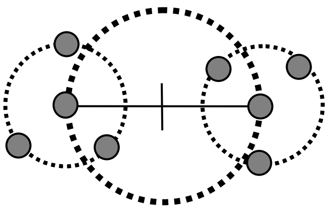
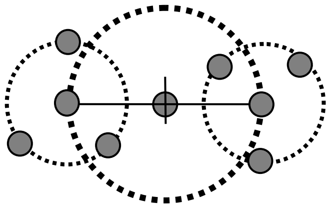
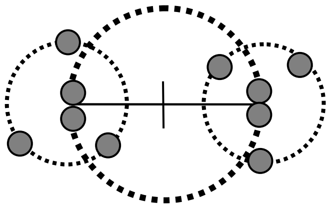
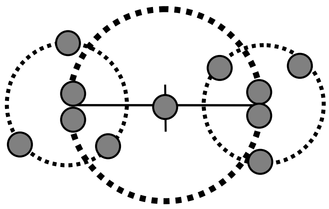
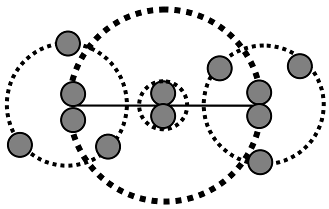
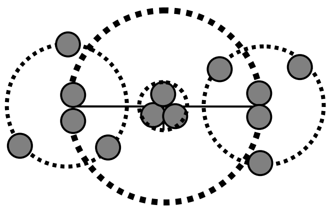
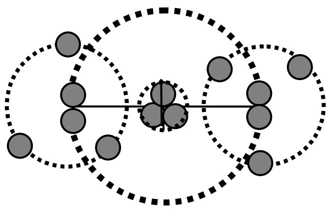
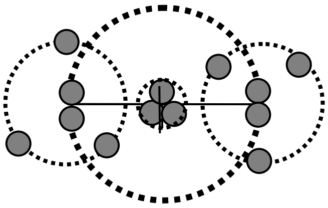
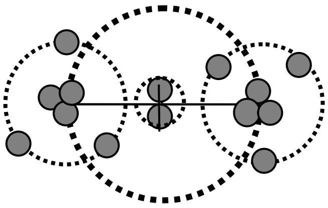
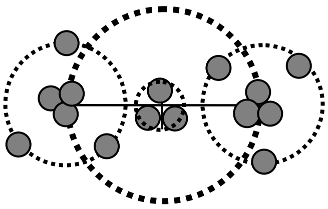
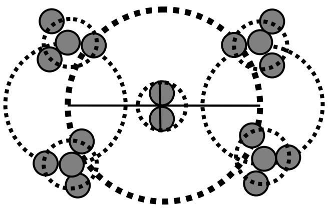
18μ'		**f_2(2300) / 2297 ± 28 MeV** $0^+(2^{++})$, Γ = 149 MeV, Dy(φφ,KK̃) $\mathbf{m \approx 16m'_{\mu}\left(1-\frac{2}{24}\right)+2m'_{\mu}\left(1-\frac{3}{24}\right)}$ $\mathbf{= 2312.7 MeV}$
18μ'		**f_2(2340) / 2345 ± 50 MeV** $0^+(2^{++})$, Γ = 322 MeV, Dy(φφ,ηη) $\mathbf{m \approx 16m'_{\mu}\left(1-\frac{2}{24}\right)+2m'_{\mu}\left(1-\frac{1}{24}\right)}$ $\mathbf{= 2336.2 MeV}$

Table 4.4 Internal designs for vector and pseudovector mesons, comprising pearls of pionet-mass ($m_{\pi o}$ = 134.9770MeV).

6π		**ρ(770) / 775.26 ± 0.34 MeV** $1^+(1^{--})$, Γ = 149.4 MeV, Dy(ππ). $\mathbf{m \approx 6m_{\pi o}\left(1-\frac{1}{24}\right)}$ $\mathbf{= 776.1 MeV}$
6π		**ω(782) / 782.65 ± 0.12 MeV** $0^-(1^{--})$, Γ = 8.49 MeV, Dy(πππ). $\mathbf{m \approx 6m_{\pi o}\left(1-\frac{1}{37.7}\right)}$ $\mathbf{= 788.4 MeV}$
8π		**φ(1020) / 1019.461 ± 0.016 MeV** $0^-(1^{--})$, Γ = 4.26 MeV, Dy(KK,ρπ). $\mathbf{m \approx 8m_{\pi o}\left(1-\frac{(4/3)}{24}\right)}$ $\mathbf{= 1019.8 MeV}$

9π 	**h_1(1170) / 1170 ± 20 MeV** $0^-(1^{+-})$, Γ = 360 MeV, Dy(ρπ). $\mathbf{m \approx 8m_{\pi o}\left(1-\frac{(4/3)}{37.7}\right)+m_{\pi o}\left(1-\frac{1}{24}\right)}$ $\mathbf{=1171.0MeV}$
10π 	**b_1(1235) / 1229.5 ± 3.2 MeV** $1^+(1^{+-})$, Γ = 142 MeV, Dy(ωπ,$K\tilde{K}$π,φ,ηρ). $\mathbf{m \approx 10m_{\pi o}\left(1-\frac{2(5/3)}{37.7}\right)}$ $\mathbf{=1230.4MeV}$
11π 	**ω(1420) / (1400-1450) MeV** $0^-(1^{--})$, Γ = 180-250 MeV, Dy(b_1(1235),ρ,ω) $\mathbf{m \approx 10m_{\pi o}\left(1-\frac{(5/3)}{37.7}\right)+m_{\pi o}\left(1-\frac{1}{37.7}\right)}$ $\mathbf{=1421.5MeV}$
12π 	**ρ(1450) / 1465 ± 25 MeV** $1^+(1^{--})$, Γ = 400 MeV, Dy(ππ,ηρ) $\mathbf{m \approx 10m_{\pi o}\left(1-\frac{2(5/3)}{37.7}\right)+2m_{\pi o}\left(1-\frac{3}{24}\right)}$ $\mathbf{=1466.7MeV}$
13π 	**ω(1650) / 1670 ± 30 MeV** $0^-(1^{--})$, Γ = 315 MeV, Dy(ρπ,ωππ,ωη) **ω_3(1670) / 1667± 4 MeV** $0^-(3^{--})$, Γ = 168 MeV, Dy(ρ,ω) $\mathbf{m \approx 10m_{\pi o}\left(1-\frac{(5/3)}{37.7}\right)+3m_{\pi o}\left(1-\frac{2}{37.7}\right)}$ $\mathbf{=1673.5MeV}$
13π 	**φ(1680) / 1680 ± 20 MeV** $0^-(1^{--})$, Γ =150 MeV, Dy($K\tilde{K}$*(892)) $\mathbf{m \approx 10m_{\pi o}\left(1-\frac{(5/3)}{37.7}\right)+3m_{\pi o}\left(1-\frac{1}{24}\right)}$ $\mathbf{=1678.2MeV}$

13π 	**ρ_3(1690) / 1688.8 ± 2.1 MeV** $1^+(3^{--})$, Γ =161 MeV, Dy(π,K$\tilde{\text{K}}$,ρ) $\mathbf{m \approx 10m_{\pi o}\left(1-\frac{(5/3)}{37.7}\right)+3m_{\pi o}\left(1-\frac{1}{37.7}\right)}$ $\mathbf{= 1684.3MeV}$
14π 	**ρ(1700) / 1720 ± 20 MeV** $1^+(1^{--})$, Γ = 250 MeV, Dy($\rho\pi\pi$, $\rho\rho$,K$\tilde{\text{K}}$) $\mathbf{m \approx 12m_{\pi o}\left(1-\frac{(6/3)}{24}\right)+2m_{\pi o}\left(1-\frac{3}{24}\right)}$ $\mathbf{= 1721.0MeV}$
15π 	**φ_3(1850) / 1854 ± 7 MeV** $0^-(3^{--})$, Γ = 87 MeV, Dy(K$\tilde{\text{K}}$*(892)) $\mathbf{m \approx 12m_{\pi o}\left(1-\frac{(6/3)}{24}\right)+3m_{\pi o}\left(1-\frac{2}{24}\right)}$ $\mathbf{= 1855.9MeV}$
18π 	**φ(2170) / 2175 ± 15 MeV** $0^-(1^{--})$, Γ = 61 MeV, Dy(KK,φ f_o(980)) $\mathbf{m \approx 16m_{\pi o}\left(1-\frac{(8/3)}{24}\right)+2m_{\pi o}\left(1-\frac{1}{24}\right)}$ $\mathbf{= 2178.4MeV}$

These designs for light unflavoured mesons show that the spin increases with mass, loosely. But all mesons with spin $J\hbar$ must obey the expression:

$$(m_s/2)c\,r_s = J\hbar \ , \qquad (4.2)$$

where m_s is only the mass in the spin-loop of radius r_s :

$$r_s = 137\,[2(e^2/m_s c^2)] \ , \qquad (4.3)$$

and the quion radius is always

$$r_q = r_s/137(2/\pi) \quad . \qquad (4.4)$$

Thus, for a given mass, the spin radius may be varied arbitrarily to produce particles of high or low density with different quion designs and properties. For example,

f_4(2050) has (J = 4) whereas φ(2170) has (J = 1), a variation in spatial density of 16 times. The number of pearls in each meson can be estimated quite reliably, but the binding energy varies greatly. Figure 4.1 shows J versus *total-mass* for these mesons. Evidently, mesons comprising pearls of pionet-mass fit (J = 1, 3), whereas those comprising muonet-mass prefer (J = 0, 2, 4) except for six with (J = 1).

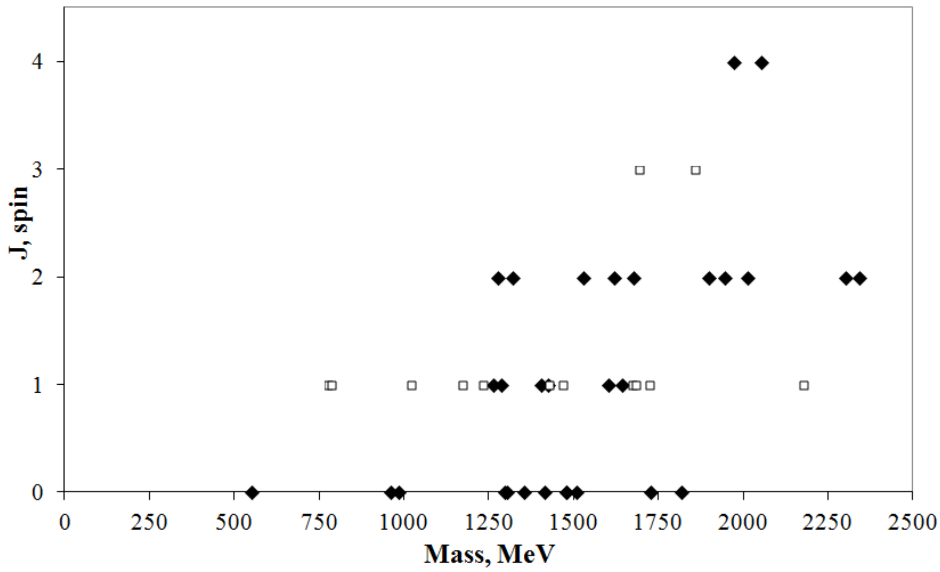


Fig.(4.1) Relationship between spin and mass for light unflavoured mesons. The solid points are for mesons in Tables 4.2 and 4.3, and hollow points are for the mesons in Table 4.4.

5. Strange mesons

5.1 General features

When angular momentum is plotted against mass for strange mesons, it is apparent that a linear relationship may exist, even though many points are vacant, see Figure 5.1. A reasonable fit exists for the empirical formula:

$$\begin{aligned} M_K &\approx 2.875(J + n/3)m_{\pi o} + m_{K\pm} \\ &\approx m_{\pi o}(3J + n)(1 - 1/24) + m_{K\pm} \end{aligned} , \quad (5.1)$$

where n is an integer for the parallel lines as marked, and ($m_{\pi o}$ = 134.9770MeV/c^2), ($m_{K\pm} = 493.677$MeV) are the pionet and kaon masses. This suggests that individual pearl-pionets are added to increment meson mass. The mean deviation of actual meson masses from Eq.(5.1) is 14MeV/c^2, which is good compared with 32MeV/c^2 for a theoretical random mass distribution.

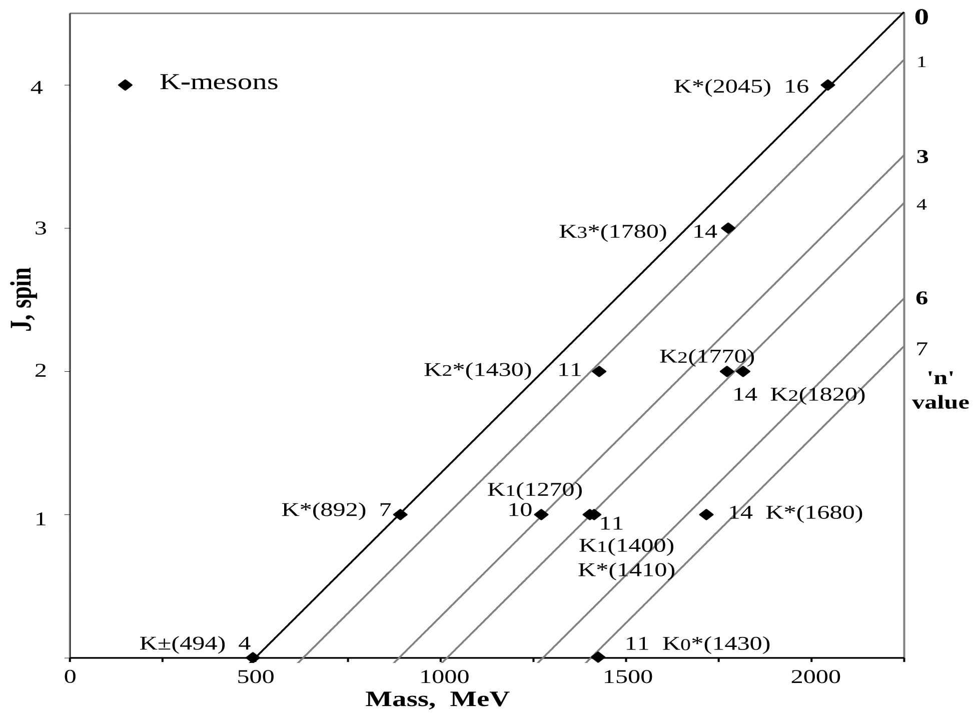


Fig.(5.1) A plot of strange meson spin against mass, according to Eq.(5.1) for the various values of ‘n’ given on the right ordinate. The number of pearl-pionets in each strange meson is marked.

Equation (5.1) implies that a strange meson resonance can easily decay into a long-lived kaon mass plus pieces, even though its own mean lifetime is very short. Likewise, an unflavoured meson such as ϕ(1020) can produce a $K\overline{K}$ *pair* when it has a quion / antiquion pair of enough mass.

Figure 5.2 represents our basic model for strange mesons, in which there are (4 + n) neutral pearl-pionets bound by gluons in the compact core of radius r_{0K} . At charge radius $r_\pm$ there is a positron for K^+ (matter) or an electron for K^- (antimatter). At the same radius there may also be a neutralising electron to produce a neutral kaon K^0 (matter), or neutralising positron to produce a neutral $\overline{K}^0$ (antimatter). It is this neutralising electron which is emitted during semi-leptonic decay of the K^0, and vice-versa. These two neutral mesons are antiparticles and differ because the core pearl-pionets have right-handed helicity within the original K^+ or left-handed helicity within the original K^-, (just as a neutron differs from an anti-neutron).

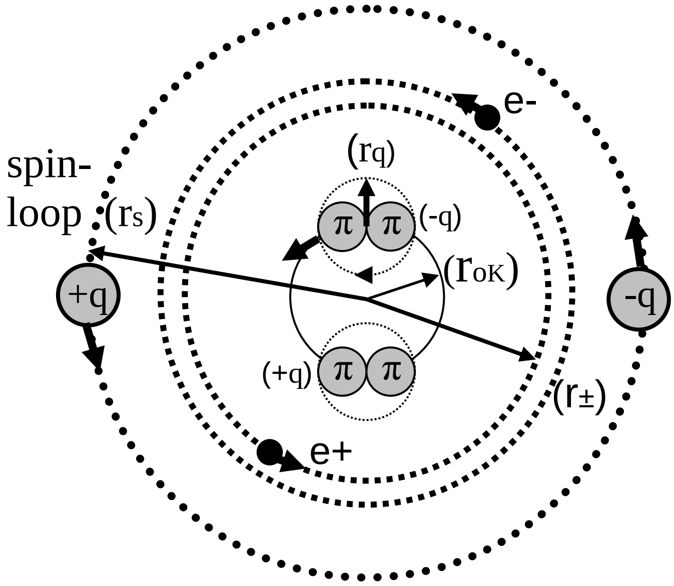


Fig.(5.2) Basic model schematic design for strange mesons, showing 4 pearl-pionets at the centre, orbited by a positron or electron, or both for a neutral meson. Pionets may also be added to the core to increase (n). Spin J is accomplished by adding pionets to the quion /antiquion pair in a spin-loop.

The core always has zero *net* spin, but overall meson spin may be produced by the quion /antiquion pair travelling at velocity c in a larger spin-loop of radius r_S. During hadronic decay, this spin-loop material plus *n* core pearl-pionets may convert rapidly into free π, ρ, etc., eventually leaving the central kaon ($2\pi^o + 2\pi^o$) intact. This spin-loop may sometimes exist for less than one rotation period, although its creation must have been completed more rapidly. For example, K*(892) has a decay full width (Γ = 50.75 MeV) which corresponds to a lifetime of ($\tau = \hbar/\Gamma = 1.3\text{x}10^{-23}$sec). Its spin-loop period is given by ($2\pi r_S/c = 2.12\text{x}10^{-23}$sec), according to Eq.(5.4). In the case of K_4*(2045), its lifetime is only $0.33\text{x}10^{-23}$sec and its spin-loop period is 2.12 x 10^{-23}sec; consequently, strange mesons with spin hardly come into existence before decaying.

The spin of a strange meson is always given by:

$$J\hbar = (M_S/2)cr_S \quad , \qquad (5.2)$$

where M_S is the *quion+antiquion* mass travelling at velocity c around the spin-loop at radius r_S . Given Figure 5.1, we will arbitrarily let the *n* pearl-pionets reside in the core, so that 3 pearl-pionets must be added to the spin-loop in order to increase J by unity, then:

$$M_S \approx J \times 2.875 m_{\pi o} \ , \tag{5.3a}$$

and Eq.(5.1) becomes

$$M_K \approx M_S + \left[\left(\frac{2.875}{3} \right) n\, m_{\pi o} + m_{K\pm} \right] \ . \tag{5.3b}$$

The spin-loop radius in Eq.(5.2) is independent of J at:

$$r_S \approx \left(\frac{2\hbar}{2.875 m_{\pi o} c} \right) = 1.017 \text{ fm} \ . \tag{5.4}$$

For all values of J, pionets added to the spin-loop are bound by *approximately* the same energy decrement, since the coefficient 2.875 implies:

$$2.875 m_{\pi o} = 3(1 - 1/24) m_{\pi o} \ . \tag{5.5}$$

The mass decrement ($m_{\pi o}$ /24) is due mainly to the quion's or antiquion's self-binding strong force, plus their mutual electromagnetic attraction.

5.2 Kaon mass structure

Kaons are denoted *strange* because of their long lifetime, which implies strong binding of the component parts. Thus, kaon mass m_{K+} is represented by 4 bound pearl-pionets through the formula:

$$m_{K+} = 493.677 \text{MeV}/c^2 \approx 4\left(1 - \frac{2}{24}\right) m_{\pi o} \ , \tag{5.6}$$

where pionet mass is 134.9770MeV/c^2 and the negative term represents the binding energy due to the strong force. The core radius r_{0K} will be given the classical value for 4 pearl-pionets arranged as a quion/antiquion pair like the pion design:

$$r_{OK} = 2 \times (e^2 / 4 m_{\pi o} c^2) = 5.334 \times 10^{-3} \text{fm} \ . \tag{5.7a}$$

Then, by analogy with the electron and proton, the K^+ charge radius is proposed to be:

$$r_\pm = \alpha^{-1} r_{0K}/2 = 0.3655 \text{fm}, \tag{5.7b}$$

where (α = 1/137.036) is the fine structure constant. And a neutralising electronic charge can be impressed into this same orbit to yield a neutral kaon K^0 of mass (m_{K0} = 497.611MeV/c^2).

Now we recall that for the neutron in Paper 1, the neutralising heavy-electron around the proton had a mass determined roughly by its radius:

$$m'_{he} = e^2/(c^2 r_{he}) \quad . \qquad (5.8a)$$

Consequently, the mass of the neutralising electron here at ($r_\pm$ = 0.3655fm) might be simply:

$$m'_- = e^2/(c^2 r_\pm) = 7.71 m_e = 3.94\,\text{MeV/c}^2 \ , \qquad (5.8b)$$

which would account for the measured difference in mass between a neutral and charged kaon:

$$m_{K0} - m_{K\pm} = 3.934 \pm 0.020\ \ \text{MeV/c}^2 \ . \qquad (5.9)$$

Furthermore, the neutralising electron needs to be stabilised by its own self-interaction energy; see Paper 1, Eq.(10.2.2). This self-binding energy would produce a heavy-electron here of energy:

$$m_- c^2 = 9 m_e c^2 - \frac{e^2}{(2\pi r_\pm)} = 7.773 m_e c^2 = 3.97\text{MeV} \ . \qquad (5.10)$$

The measured charge radius for the $K^\pm$ is <r> = 0.560 ± 0.031fm, see PDG (2018). This is an *effective* interaction size, to be compared with our real *source* size ($r_\pm$ = 0.3655fm). Likewise, the effective/measured size of K^0 is $\langle r^2 \rangle$ = -0.077 ± 0.010fm^2, which implies that the negative and positive charges together at ($r_\pm$) interact differently with electrons in liquid hydrogen, so as to produce a net effective radius.

5.3 Mean lifetime

The long lifetime of a kaon can be attributed partly to the surrounding charge, with due regard to its particular spin orientation. The basic K^+ has a 4-pearl-pionet core structure ($2\pi^o + 2\pi^o$) which appears unable to exist by itself without its positron. Decay of a kaon occurs via the weak force, which is interpreted as natural jostling between constituent parts.

K^+. The kaons $K^\pm$ have a central core period of ($2\pi r_{OK}/c = 1.12\text{x}10^{-25}$secs), so the number of periods in its mean life of ($\tau_\pm = 1.2380\text{x}10^{-8}$secs) is:

$$N_{K\pm} = \tau_\pm /(2\pi r_{0K}/c) = 1.11\times 10^{17} \quad . \qquad (5.11a)$$

This very large ratio is reminiscent of the pion Eq.(2.19), and will be interpreted in terms of guidewave action and coherence length. First, taking a logarithm:

$$\ln(N_{K\pm}) \approx 4\pi^2 \ , \qquad (5.11b)$$

and after differentiating and multiplying through by [($e^2/c = 4m_{\pi o}cr_{0K}/2 = 2m_q c'r_q/2$) using Eq.(2.1)] we get:

$$\int_{2\pi r_{0K}}^{N_{K\pm}(2\pi r_{0K})} \left(\frac{1}{2}\right)\left(\frac{(e/2)^2}{z}\right)dt \approx \int_0^{2\pi}\left(\frac{m_q}{2}\right)c' r_{0K}\, d\theta \quad . \qquad (5.11c)$$

On the left, a core-pearl charge is (e/2) and the integral represents potential energy action required to create/dissipate the pearl travelling around the core circumference ($2\pi r_{0K}$). The right side represents kinetic action of a quion binary pearl rotating at velocity (c') describing epicycles around the core circumference.

$\mathbf{K^0_L}$. The extended lifetime of this kaon (τ_{0L} = 5.116x10^{-8}s) implies that the neutralising heavy-electron with the native positron must interact constructively with the co-rotating core, (as for our neutron model). This lifetime represents a number of periods for the heavy-electron at ($r_\pm$ = 0.3655fm):

$$N_{K0L} = \tau_{0L}/(2\pi r_\pm/c) = 6.68\times 10^{15}. \qquad (5.12a)$$

Again this ratio is interesting because of its interpretation in terms of guidewave action and coherence time, through the formula:

$$\ln(N_{K0L}) \approx 2\pi(137/24) \quad , \qquad (5.12b)$$

which after differentiation may be reduced with Eq.(5.7) to:

$$\left(\frac{1}{137}\right)\int_{2\pi r_\pm}^{N_{KOL}(2\pi r_\pm)}\left(\frac{1}{2}\right)\frac{e^2}{z}dt = \left(\frac{1}{24}\right)\int_0^{2\pi}\left(\frac{m_q}{2}\right)c\, r_{OK}\, d\vartheta \quad . \qquad (5.12c)$$

This expression accounts for the long lifetime by coordinating action in the neutralising heavy-electron and the core mechanism; compare with Eq.(2.22). On the left, the integral is potential energy action required to create the heavy-electron with its spiralling electromagnetic guidewave, which communicates continuously with the core to stabilise it. Weighting coefficient (1/137) records that the electron core consists of 137 electron-pearls (see Paper 2). The integral on the right is kinetic energy action for a core-quion running around the core, at radius r_{OK}. Coefficient (1/24) confirms there were 24 original pearl-seeds in each pearl.

$\mathbf{K^0_S}$. The greatly reduced lifetime of this kaon (τ_{0S} = 0.8956x10^{-10}s) implies that the neutralising heavy-electron with the native positron cannot stabilise a counter-rotating core. The lifetime is around 137 times less than the above ($\tau_{\pm}$ = 1.2380x10^{-8}secs) and represents fewer core periods ($2\pi r_{OK}/c$ = 1.12x10^{-25}secs):

$$N_{K0S} = \tau_{0S}/(2\pi r_{OK}/c) = 8.01\times 10^{14} \qquad (5.13a)$$

This ratio may be interpreted in terms of guidewave action and coherence through the formula:

$$\ln(N_{K0S}) \approx (e_n/\pi)4\pi^2 , \qquad (5.13b)$$

which after differentiating may be reduced to a variation of Eq.(5.11c):

$$\int_{2\pi r_{0K}}^{N_{K0S}(2\pi r_{0K})} \left(\frac{1}{2}\right)\left(\frac{(e/2)^2}{z}\right) dt \approx \left(\frac{e_n}{\pi}\right)\int_0^{2\pi}\left(\frac{m_q}{2}\right) c' r_{0K} d\theta \quad . \qquad (5.13c)$$

On the left, a core-pearl charge is (e/2) and the integral represents potential energy action required to create the pearl and guidewave travelling around the core. The right side represents kinetic action of a quion binary pearl rotating at velocity (c') describing epicycles around the core circumference ($2\pi r_{0K}$). Factor (e_n/π) appeared earlier in Eq.(2.15) to cover the contribution from gluons to the stabilising guidewave field operating around the pion. However in this K_S^0 kaon, the counter-rotating core does not contribute to stabilisation so the $4\pi^2$ term of Eq.(5.11b) has to be reduced by (e_n/π).

The fact that K_L^0 and K_S^0 are produced in equal quantity will be attributed to random orientation of the core spin relative to the angular momentum of orbiting charge. Energy difference of 3.491x10^{-12}MeV between the states is then comparable with the hyperfine splitting of interstellar hydrogen (5.874x10^{-12} MeV). The higher energy state K_L^0 is expected to be for parallel spins, which is evidently more stable. Regeneration of K_S^0 during interaction of K_L^0 with matter is understandable in terms of spin inversion. Earlier, the extended lifetime of the K_L^0 relative to that of $K^{\pm}$ was proposed to be due to the stabilising effect of the neutralising charge on the co-rotating core, through the spiralling guidewaves. This is analogous to the charged pion being more stable than the neutral pion.

According to observations, neutral kaons K_L^0 oscillate between the matter and anti-matter state while propagating. In quark theory, this has been explained (see

Perkins, 2000), as being due to a second-order weak interaction which also causes K_L^0 and K_S^0 particles to have the different masses mentioned above:

$$\Delta m = m_{KL} - m_{KS} = 3.491x10^{-12}\,MeV/c^2, \qquad (5.14)$$

and the oscillation period is ($\tau_0 = h/\Delta mc^2 = 1.18786x10^{-9}$ s). Herein, the K_L^0 and $\overline{K}_L^0$ must have equal status and such oscillations could be attributed to a change in *helicity of the core* from right-handed for K_L^0 to left-handed for $\overline{K}_L^0$, maybe due to prompting from the orbiting charges. Figure 5.3 illustrates our model for the 4 possible particles. It is anti-parallel spin of the core, not helicity, which causes the shorter lifetime for K_S^0 and $\overline{K}_S^0$.

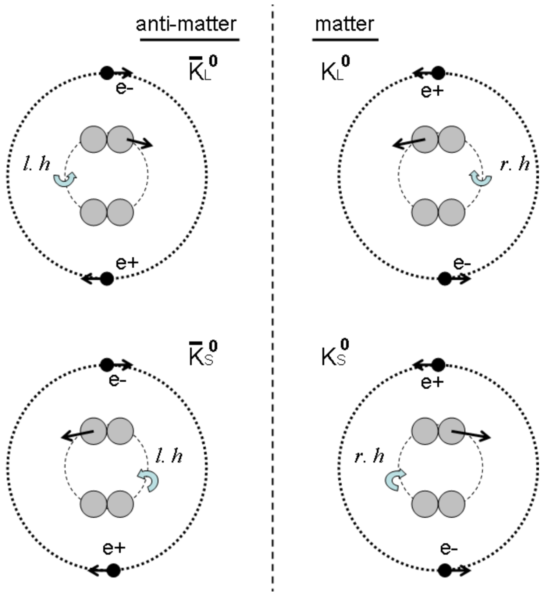
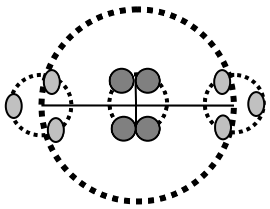
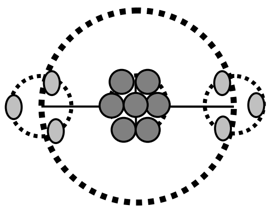
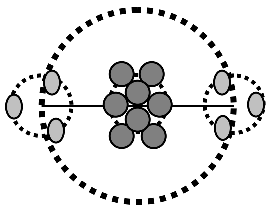
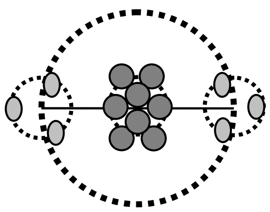
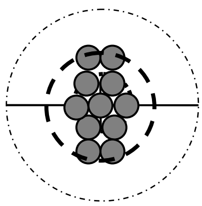


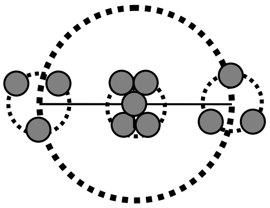
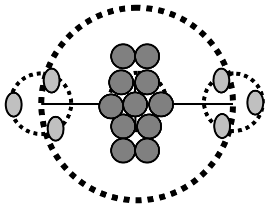
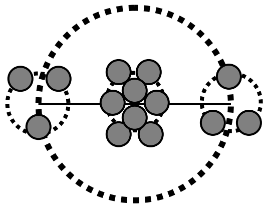
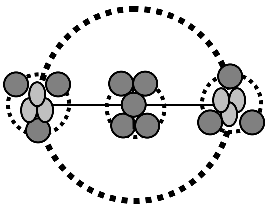
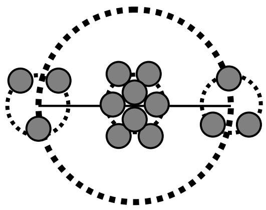
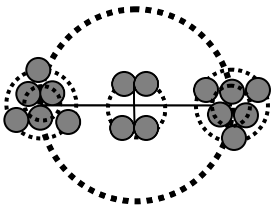
Fig.(5.3) Schematic diagram of the K_L^0 and K_S^O neutral kaons with their anti-kaons $\overline{K}_L^0$ and $\overline{K}_S^0$.

5.4 General designs of strange mesons

According to Figure 5.1 strange mesons consist of (4 + n) bound pearl-pionets in a central core, plus a quion /antiquion pair in the spin-loop, as drawn in Figure 5.2. Three pearl-pionets must be added to the spin-loop to increase J by unity. By considering the decay products and kinetic energy, it is possible to derive a design for each meson. Thus the decay process is to be regarded as relaxation in which component parts separate ergonomically, preserving some features when the free energy is low. Table 5.1 illustrates some tentative designs for strange mesons, and the proposed formulae (with core component first) satisfy their mass distribution fairly well in terms of pionet mass ($m_{\pi o}$ = 134.9770MeV/c^2).

Table 5.1 Design of strange mesons based upon ergonomic agreement with their decay products. The pearls shown as ovals have half the pionet mass.

7π 	**K*(892) / 891.66 ± 0.26 MeV** ½(1⁻), Γ = 48.5 MeV, Dy(Kπ) $\mathbf{m \approx 4m_{\pi o}\left(1-\frac{3/2}{24}\right)+3m_{\pi o}\left(1-\frac{1}{24}\right)}$ **= 894.2MeV**
10π 	**K1(1270) / 1272 ± 7 MeV** ½(1⁺), Γ = 90 MeV, Dy(Kρ,K*(892)) $\mathbf{m \approx 7m_{\pi o}\left(1-\frac{3/2}{24}\right)+3m_{\pi o}\left(1-\frac{1}{24}\right)}$ **= 1273.9MeV**
11π 	**K1(1400) / 1403 ± 7 MeV** ½(1⁺), Γ = 174 MeV, Dy(K*(892)π,Kρ) $\mathbf{m \approx 8m_{\pi o}\left(1-\frac{3/2}{24}\right)+3m_{\pi o}\left(1-\frac{1}{24}\right)}$ **= 1400.4MeV**
11π 	**K*(1410) / 1414 ± 15 MeV** ½(1⁻), Γ = 232 MeV, Dy(K*(892)π,Kρ) $\mathbf{m \approx 8m_{\pi o}\left(1-\frac{1}{24}\right)+3m_{\pi o}\left(1-\frac{1}{24}\right)}$ **= 1422.9MeV**
11π 	**K0*(1430) / 1425 ± 50 MeV** ½(0⁺), Γ = 270 MeV, Dy(Kπ) $\mathbf{m \approx 11m_{\pi o}\left(1-\frac{1}{24}\right)}$ **= 1422.9MeV**

11π 	**K_2*(1430) / 1425.6 ± 1.5 MeV** ½(2^+), Γ = 98.5 MeV, Dy(K*(892),Kρ) $\mathbf{m \approx 5m_{\pi o}\left(1-\frac{1}{24}\right)+6m_{\pi o}\left(1-\frac{1}{24}\right)}$ $\mathbf{= 1422.9MeV}$
14π 	**K*(1680) / 1717 ± 27 MeV** ½(1^-), Γ = 322 MeV, Dy(Kπ,Kρ,K*(892)) $\mathbf{m \approx 11m_{\pi o}\left(1-\frac{3}{24}\right)+3m_{\pi o}\left(1-\frac{1}{24}\right)}$ $\mathbf{= 1687.2MeV}$
14π 	**K_2(1770) / 1773 ± 8 MeV** ½(2^-),Γ = 186MeV, Dy(K_2*(1430), K*(892)) $\mathbf{m \approx 8m_{\pi o}\left(1-\frac{2}{24}\right)+6m_{\pi o}\left(1-\frac{1}{24}\right)}$ $\mathbf{= 1765.9MeV}$
14π 	**K_3*(1780) / 1776 ± 7 MeV** ½(3^-), Γ = 159 MeV, Dy(Kρ,K*(892)π,Kη) $\mathbf{m \approx 5m_{\pi o}\left(1-\frac{2}{24}\right)+9m_{\pi o}\left(1-\frac{1}{24}\right)}$ $\mathbf{= 1782.8MeV}$
14π 	**K_2(1820) / 1816 ± 13 MeV** ½(2^-), Γ = 276MeV, Dy(K2*(1430),f2(1270)) $\mathbf{m \approx 8m_{\pi o}\left(1-\frac{1}{24}\right)+6m_{\pi o}\left(1-\frac{1}{24}\right)}$ $\mathbf{= 1810.9MeV}$
16π 	**K_4*(2045) / 2045 ± 9 MeV** ½(4^+), Γ = 198 MeV, Dy(φK*(892),ρKπ) $\mathbf{m \approx 4m_{\pi o}\left(1-\frac{2}{24}\right)+12m_{\pi o}\left(1-\frac{1}{24}\right)}$ $\mathbf{= 2047.1MeV}$

Meson K_0*(1430) apparently has no spin-loop yet accommodates 11 pearl-pionets in the core. It has a very short lifetime (τ = 0.22x10^{-23} s) and could consist of a quion + antiquion pair which *closely* orbit the inner core of 7 pionets in counter-rotation.

5.5 Charge neutralisation of K*(892) and K_2*(1430)

These strange mesons have been measured in their neutral and charged states. Mass differences are given by:

$$K^*(892)^o - K^*(892)^{\pm} = 3.89 \pm 0.33\text{MeV} \approx 7.61 m_e c^2, \qquad (5.15)$$

$$K_2^*(1430)^o - K_2^*(1430)^{\pm} = 6.8 \pm 2.0\text{MeV} \approx 13.3 m_e c^2 \ . \qquad (5.16)$$

As found for the kaon, the increased mass of the neutralised meson will be attributed to adding a heavy-electron mass, without any change in the quion /anti-quion spin-loop or mass. At present, the data accuracy for K_2*(1430) does not allow derivation of a reliable model.

K*(892). If, following Eq.(5.8a) with Eq.(5.15), the heavy-electron radius were smaller than the free electron classical radius (r_{oe} = 2.81794fm) at ($r_{ohe} = r_{oe}/7.61$ = 0.370fm), it would approximate to ($r_{\pm}$ = 0.3655fm) in the central kaon, Eq.(5.7b). An actual fit to ($r_{\pm}$) seems likely and would require a mass difference of 3.94MeV = 7.71m_e in Eq.(5.15).

The compression sequence of the heavy-electron follows that of the neutron in Paper 1, and by analogy in the final stage it is quantisable in terms of action because [$\ln(r_{oe}/r_{he}) \approx \ln(7.71) \approx 2\pi/3$], which leads to an action integral by differentiating then multiplying by ($e^2 = m_{he} c r_{ohe}$):

$$-\int_{2\pi r_{oe}}^{2\pi r_{he}} \frac{1}{2}\frac{e^2}{z}\,dt \approx \int_0^{2\pi/3} \frac{m_{he}}{2} c r_{ohe}\, d\theta \quad . \qquad (5.17)$$

On the left is the integral for potential energy action done in compressing the electron, and on the right is the kinetic energy action of an electron core over one third of an orbit; cf. Paper 1, Eq.(10.2.7).

5.6 Mean lifetimes of K-mesons

(a) K*(892). The full widths of the charged and neutral mesons are similar, so their lifetimes are probably independent of the charge. The full width ($\Gamma_{K*(892)}$ ~ 48.5 MeV) implies a lifetime (τ_K = 1.35×10^{-23}s), which is less than the spin-loop period ($2\pi r_S/c$ = 2.13×10^{-23}s from Eq.(5.4)). Therefore, the lifetime may be related to the period of the rotating quion which is 137 times smaller, ($2\pi r_q/c'$ = 1.55 x 10^{-25}s) thus:

$$N_{Kq} = \tau_K /(2\pi r_q / c') = 87.1 \quad , \tag{5.18}$$

and then

$$\ln\left(N_{Kq}\right) = 4.46 \approx (\pi/4)(137/24) \quad . \tag{5.19}$$

Upon differentiating and multiplying by $(e^2/c = m_q c r_S/137)$, this reduces to an action integral like Eq.(3.2.6) for the ρ meson:

$$\int_{(2\pi r_S/137)}^{N_{Kq}(2\pi r_S/137)} \left(\frac{1}{2}\right)\frac{e^2}{z}dt \approx \left(\frac{1}{24}\right)\left(\frac{1}{4}\right)\int_0^{2\pi}\left(\frac{m_q}{2}\right)c\,r_S\,\frac{d\theta}{2} \quad . \tag{5.20}$$

On the left is the potential energy action required to create a quion, where ($z = ct$) over a guidewave coherence length. The integral on the right side represents kinetic energy action of the quion travelling around half the *spin-loop*. Coefficient (1/24) indicates that the quion originally comprised 24 pearl-seeds but the action of only one is considered here. These 24 pearl-seeds formed into the 3 pearls.

(b) K_1*(1270) through to K_4*(2045). These mesons have lifetimes less than K*(892), with action integrals within 30% of Eq.(5.20).

6 Some charmed and bottom mesons

6.1 *J/Ψ*(1*S*) $c\bar{c}$ meson: $m_{\psi 1}$ = 3096.916 MeV/c^2, $I^G(J^{PC}) = 0^-(1^{--})$

As for other particles, only half its mass is contained in the spin-loop, then following the ρ meson Eq.(3.2.1):

$$(m_{\psi 1}/2)c r_{\psi 1} = 1\hbar \quad , \tag{6.1.1}$$

and spin-loop radius is 137 times the classical radius ($r_{o\psi}$):

$$r_{\psi 1} = 2(\hbar/m_{\psi 1}c) = 137[2(e^2/m_{\psi 1}c^2)] = 137 \times r_{o\psi 1} \quad . \tag{6.1.2}$$

The mass is around that of 24 bound pions and is thought to take the design of 12 pearls in the quion and 12 in the anti-quion, as shown in Figure 6.1. Quion mass is:

$$m_q = \frac{3096.916\text{MeV}/c^2}{2} \approx 12 \times (m_{\pi o})\left(1 - \frac{1}{24}\right) \quad . \tag{6.1.3}$$

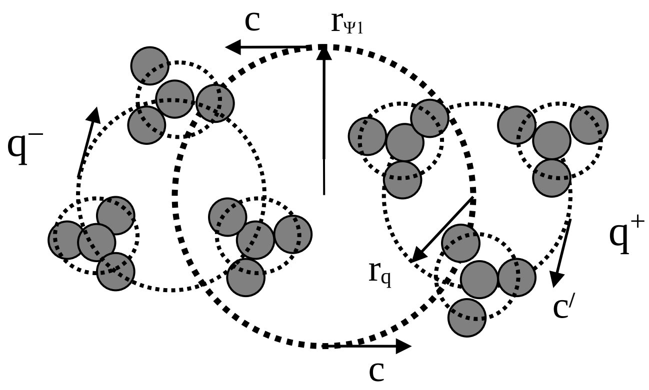


Fig.(6.1) Component parts for the *J/Ψ*(1*S*) $c\tilde{c}$ meson.

These pearls are probably smaller than the quion by 24 times, and the quions are much smaller than the spin-loop:

$$r_q = r_{\psi 1}/137(2/\pi) \quad . \tag{6.1.4}$$

The *electromagnetic* lifetime given by $(\tau_{\psi 1e} = \hbar/\Gamma_{\psi 1e} = 1.190\times10^{-19}\text{s})$ for $(\Gamma_{\psi 1e} = 5.53\text{keV})$, may be related to half the spin-loop period $(\pi r_{\psi 1}/c = 1.334 \times 10^{-24}\text{s})$ by:

$$N_{\psi 1e} = \tau_{\psi 1e}/(\pi r_{\psi 1}/c) = 8.92\times10^4, \tag{6.1.5a}$$

and then

$$\ln(N_{\psi 1e}) = 11.40 \approx \pi(137/37.7) \quad . \tag{6.1.5b}$$

By differentiating and introducing Eq.(6.1.2), this may be reduced to an action integral like Eq.(3.2.13):

$$\int_{\pi r_{\psi 1}}^{N_{\psi 1e}(\pi r_{\psi 1})} \left(\frac{1}{2}\right)\frac{e^2}{z}dt \approx \left(\frac{1}{37.7}\right)\int_0^{2\pi}\left(\frac{m_q}{2}\right)cr_{\psi 1}\frac{d\theta}{2} \quad . \tag{6.1.6}$$

On the left is potential energy action required to create (or dissipate) a quion, where $(z = ct)$ over the guidewave coherence length. The integral on the right side represents kinetic action of a quion as it travels around half the spin-loop. Factor 37.7 implies there were originally 37 pearl-seeds and only one is being considered. These 37 pearl-seeds formed into 12 pearls.

The full width $(\Gamma_{\psi 1} = 92.9\text{ keV})$ implies a strong lifetime $(\tau_{\psi 1} = 7.085\times10^{-21}\text{s})$ which may be related to the classical period $(2\pi r_{o\psi 1}/c = 1.949 \text{ x } 10^{-26}\text{s})$:

$$N_{o\psi 1} = \tau_{\psi 1}/(2\pi r_{o\psi 1}/c) = 3.64\times10^5 \quad , \tag{6.1.7a}$$

and then,

$$\ln\left(N_{o\psi1}\right)=12.8\approx 4\pi \quad . \tag{6.1.7b}$$

Upon differentiating and applying Eqs.(6.1.2), this reduces to an action integral:

$$\int_{(2\pi r_{o\psi1})}^{N_{o\psi1}(2\pi r_{o\psi1})}\left(\frac{1}{2}\right)\frac{e^2}{z}dt \approx \int_0^{2\pi}\left(\frac{m_{\psi1}}{2}\right)c\,r_{o\psi1}d\theta \quad . \tag{6.1.8}$$

On the left is the amount of potential energy action required to create a core by assembly of charge from the guidewave coherence length ($N_{o\psi1}$ x $2\pi r_{o\psi1} = c\tau_{\psi1}$). The integral on the right is kinetic action for the quions travelling around a classical circumference ($2\pi r_{o\psi1}$).

6.2 $\Upsilon(1S)$ $b\bar{b}$ meson: $m_{\gamma1}$ = 9460.30MeV/c^2, $I^G(J^{PC}) = 0^-(1^{--})$

As for other particles, only half its mass is contained in the spin-loop, then following Eq.(3.2.1):

$$(m_{\gamma1}/2)cr_{\gamma1} = \hbar \quad , \tag{6.2.1}$$

and spin-loop radius is 137 times the classical radius ($r_{o\gamma}$):

$$r_{\gamma1} = 2(\hbar/m_{\gamma1}c) = 137[2(e^2/m_{\gamma1}c^2)] = 137\times r_{o\gamma} \quad . \tag{6.2.2}$$

The mass is around that of 72 bound pions and is thought to take the design of 36 pearls in the quion and 36 in the anti-quion, as shown in Figure 6.2. Quion mass is:

$$m_q = \frac{9460.30\text{MeV}/c^2}{2} \approx 12\times\left(3m_{\pi o}\right)\left(1-\frac{1}{37.7}\right) \quad . \tag{6.2.3}$$

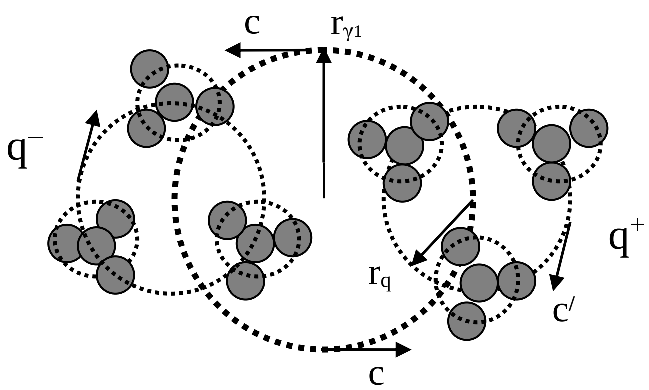


Fig.(6.2) Component parts for the $\Upsilon(1S)$ $b\tilde{b}$ meson.

These bound pearls are probably 37.7 times smaller than the quion, and the quions are much smaller than the spin-loop:

$$r_q = r_{\gamma 1}/137(2/\pi) \quad . \tag{6.2.4}$$

The *electromagnetic* lifetime given by $(\tau_{\gamma 1e} = \hbar/\Gamma_{\gamma 1e} = 4.912\times 10^{-19}\mathrm{s})$ for width ($\Gamma_{\gamma 1e}$ = 1.340keV), and the spin-loop period ($2\pi r_{\gamma 1}/c = 8.743 \times 10^{-25}$s) may be related by:

$$N_{\gamma 1e} = \tau_{\gamma 1e}/(2\times 2\pi r_{\gamma 1}/c) = 2.809\times 10^5 , \tag{6.2.5a}$$

where double the spin-loop period has been used, as if (J = 2) during creation, in order to get:

$$\ln\left(N_{\gamma 1e}\right) = 12.55 \approx 4\pi \quad . \tag{6.2.5b}$$

Upon differentiating and applying Eq.(6.2.2), this reduces to an action integral:

$$\int_{(2\times 2\pi r_{\gamma 1})}^{N_{\gamma 1e}(2\times 2\pi r_{\gamma 1})} \left(\frac{1}{2}\right)\frac{e^2}{z}dt \approx \int_0^{2\pi}\left(\frac{m_{\gamma 1}}{2}\right)c\, r_{o\gamma}d\theta \quad . \tag{6.2.6}$$

On the left is the amount of potential energy action required to create a quion by assembly of charge from the guidewave coherence length [$N_{\gamma 1e}(2x2\pi r_{\gamma 1}) = c\tau_{\gamma 1e}$]. The integral on the right is equivalent kinetic action for the two quions travelling around a classical circumference ($2\pi r_{o\gamma}$).

The full width ($\Gamma_{\gamma 1}$ = 54.02keV) implies a strong lifetime ($\tau_{\gamma 1} = 1.218\times 10^{-20}$s) which may be related to a third of the quion period ($2\pi r_q/3c' = 2.127 \text{ x } 10^{-27}$s):

$$N_{\gamma 1q} = \tau_{\gamma 1}/(2\pi r_q/3c') = 5.729\times 10^6 \quad , \tag{6.2.7a}$$

and then

$$\ln\left(N_{\gamma 1q}\right) = 15.56 \approx \pi^3/2 \quad . \tag{6.2.7b}$$

After differentiation, this with Eqs.(6.2.2),(6.2.4) can be reduced to an action integral:

$$\int_{(2\pi r_q/3)}^{N_{\gamma 1q}(2\pi r_q/3)} \left(\frac{1}{2}\right)\frac{e^2}{z}dt \approx \int_0^{2\pi}\left(\frac{m_q}{2}\right)c' r_q d\theta \quad . \tag{6.2.8}$$

On the left is the amount of potential energy action required to create a quion by assembly of charge from the guidewave coherence length $N_{\gamma 1q}(2\pi r_q/3)$. The integral on the right is kinetic action for the quion pearls travelling at velocity c' around a quion circumference ($2\pi r_q$).

6.3 B_c^+ $c\bar{b}$ meson: m_{Bc} = 6274.9MeV/c^2, I(J^{PC}) = ?(?$^?$) = 0(0^-)

The mass is around that of 48 bound pions and is thought to take the design of 24 pearls in the quion and 24 in the anti-quion, as shown in Figure 6.3. Quion mass is:

$$m_q = \frac{6274.9\text{MeV}/c^2}{2} \approx 12\times(2m_{\pi o})\left(1-\frac{1}{37.7}\right) . \qquad (6.3.1)$$

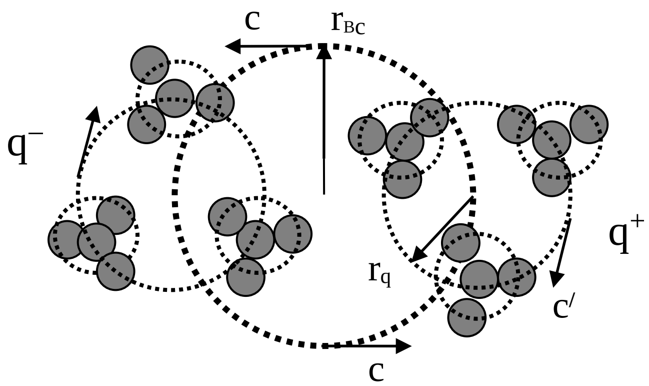


Fig.(6.3) Component parts for the B_c^+ meson.

The lifetime (τ_{Bc} = 5.10 ×10^{-13}s) may be related to the *proposed* period of the rotating quion ($2\pi r_q$ /c' = 9.62 x 10^{-27}s):

$$N_{Bcq} = \tau_{BC}/(2\pi r_q / c') = 5.30\times 10^{13} \quad , \qquad (6.3.2a)$$

and then

$$\ln(N_{Bcq}) = 31.60 \approx \pi^3 \quad . \qquad (6.3.2b)$$

After differentiation, this like Eq.(6.2.7b) can be reduced to an action integral:

$$\int_{(2\pi r_q)}^{N_{Bcq}(2\pi r_q)} \left(\frac{1}{2}\right)\frac{e^2}{z}dt \approx 2\int_0^{2\pi}\left(\frac{m_q}{2}\right)c' r_q d\theta \quad . \qquad (6.3.3)$$

On the left is the amount of potential energy action required to create a quion by assembly of charge from the guidewave coherence length $N_{Bcq}(2\pi r_q)$. The integral on the right is kinetic action for the pearls travelling at velocity c' around their quion circumference ($2\pi r_q$). This satisfactory result like Eq.(6.2.8) had to be obtained by assuming that (J = 1) *during creation* in order to use the appropriate quion period, which is $(\pi/2)^2$ times larger than the quion period for (J = 0).

6.4 *B⁰* $d\bar{b}$ meson: m_{Bo} = 5279.64MeV/c², I(J^P^) = ?(?^?^) = ½(0⁻)

The mass is around that of 42 bound pions and is thought to take the design of 21 pearls in the quion and 21 in the anti-quion, see Figure 6.4. Quion mass is:

$$m_q = \frac{5279.64\text{MeV}/c^2}{2} \approx 3\times(7m_{\pi o})\left(1-\frac{1}{37.7}\right)\left(1-\frac{1}{24}\right) . \quad (6.4.1)$$

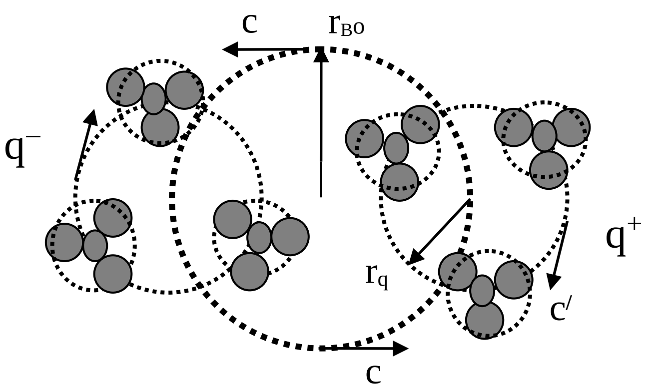


Fig.(6.4) Component parts for the ***B⁰*** meson.

Using equivalent of Eqs.(6.2.2), (6.2.4), the lifetime (τ_{Bo} = 1.519 ×10^{-12}s) may be related to the *proposed* period of the rotating quion ($2\pi r_q$ /c' = 1.142 x 10^{-26}s):

$$N_{Boq} = \tau_{Bo} /(2\pi r_q / c') = 1.33\times 10^{14} \quad , \qquad (6.4.2a)$$

and then

$$\ln\left(N_{Boq}\right) = 32.5 \approx \pi^4 / 3 \quad . \qquad (6.4.2b)$$

After differentiation, this with Eqs.(6.2.2), (6.2.4) can be reduced to an action integral similar to Eq.(3.2.8) for the ρ meson:

$$\int_{(2\pi r_q)}^{N_{Boq}(2\pi r_q)} \left(\frac{1}{2}\right)\frac{e^2}{z'}dt \approx 2\int_0^{2\pi}\left(\frac{2m_q}{2}\right)c' r_q \frac{d\theta}{3} \quad . \qquad (6.4.3)$$

On the left is the amount of potential energy action required to create a quion by assembly of charge from the guidewave coherence length $N_{Boq}(2\pi r_q)$. The integral on the right is kinetic action for all the pearls travelling at velocity c' around a third of their quion circumference ($2\pi r_q/3$). This result was obtained by assuming (J = 1) *during creation*.

6.5 D^0 c$\bar{u}$ meson: m_{Do} = 1864.83MeV/c², I(J^P) = ½(0⁻)

The mass is around that of 16 bound pions and is thought to take the design of 8 pearls in the quion and 8 in the anti-quion, see Figure 6.5. Quion mass is:

$$m_q = \frac{1864.83\mathrm{MeV}/c^2}{2} \approx 4\times(2m_{\pi o})\left(1-\frac{(4/3)}{24}\right)\left(1-\frac{2}{24}\right) . \quad (6.5.1)$$

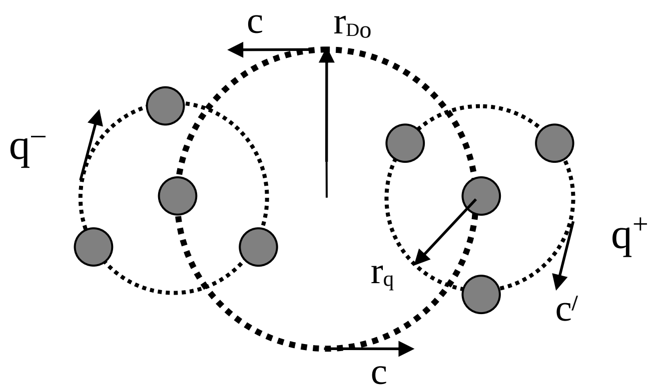


Fig.(6.5) Component parts for the **D⁰** meson.

Using Eqs.(6.2.2), (6.2.4) again, the lifetime (τ_{Do} = 4.10 ×10^{-13}s) may be related to one third of the quion period ($2\pi r_q$ /3c' = 1.078 x 10^{-26}s):

$$N_{Doq} = \tau_{Do} /(2\pi r_q / 3c') = 3.80\times 10^{13} \quad , \qquad (6.5.2a)$$

and then

$$\ln\left(N_{Doq}\right) = 31.3 \approx \pi^3 \quad . \qquad (6.5.2b)$$

After differentiation, this can be reduced to an action integral like Eq.(3.2.23) for the ϕ(1020) meson:

$$\int_{(2\pi r_q/3)}^{N_{Doq}(2\pi r_q/3)} \left(\frac{1}{2}\right)\frac{e^2}{z}dt \approx 2\int_0^{2\pi}\left(\frac{m_q}{2}\right)c' r_q d\theta \quad . \qquad (6.5.3)$$

On the left is the amount of potential energy action required to create a quion by assembly of charge from the guidewave coherence length $N_{Doq}(2\pi r_q/3)$. The integral on the right is kinetic action for the quion pearls travelling at velocity c' around a quion circumference ($2\pi r_q$). Again, (J = 1) was assumed *during creation*.

6.6 The Higgs boson candidate

A new particle CERN(125), of mass around 125.3GeV/c^2 has been presented as a Higgs boson by the ATLAS and CMS Collaborations (2012). Nevertheless, mass is already accounted for as localised energy, so there is no need for an ethereal Higgs field. Therefore this particle appears to be a neutral meson of zero spin with mass given by:

$$m_{125} \approx 2\times\left\{12\times(42m_{\pi o})\left(1-\frac{2}{24}\right)\right\}=124.7\text{GeV}/c^2 \quad . \qquad (6.6.1a)$$

Here, the quion and anti-quion components each contain 12 super-pionets which are 42 times heavier than standard pionets ($m_{\pi o}$ = 134.9770MeV/c^2), as shown in Figure 6.6. Clearly this meson can decay into the various matter/antimatter particles observed, such as a $b\tilde{b}$ meson which is less massive than one of the 12 super-pionet pairs.

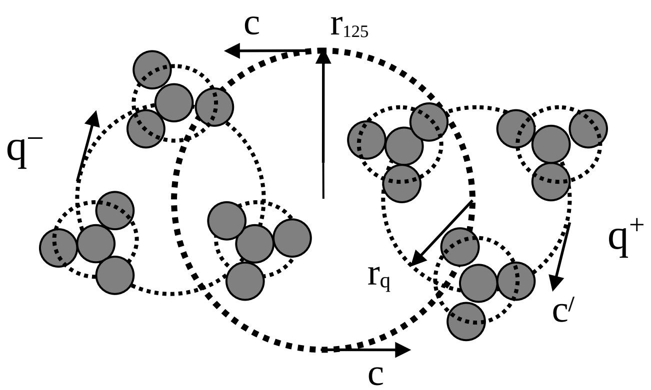


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Fig.(6.6) Component parts for the CERN(125) meson

For width (Γ = 4.2MeV), the mean lifetime of this meson is estimated to be $(\tau_{125}=\hbar/\Gamma=1.56\times10^{-22}\text{s})$. The classical core radius is:

$$r_{125}=2\times e^2/m_{125}c^2 = 2.30\times10^{-5}\,\text{fm} \, . \qquad (6.6.2)$$

Then the lifetime can be related to the core period $(2\pi r_{125}/c=4.83\times10^{-28}\text{s})$ in the ratio:

$$N_{125}=\tau_{125}/(2\pi r_{125}/c)=3.23\times10^5, \qquad (6.6.3a)$$

and taking logarithms,

$$\ln(N_{125})=12.68\approx 4\pi \quad . \qquad (6.6.3b)$$

After differentiation and introduction of Eq.(6.6.2), this can be reduced to a creation action integral like Eq.(6.1.8) for J/Ψ(1S) meson:

$$\int_{2\pi r_{125}}^{N_{125}(2\pi r_{125})} \left(\frac{1}{2}\right)\frac{e^2}{z}\,dt \approx \int_0^{2\pi}\left(\frac{m_{125}}{2}\right)c\,r_{125}\,d\theta \quad . \qquad (6.6.4)$$

On the left is the amount of potential energy action required to create a quion by assembly of charge from the guidewave coherence distance (N_{125} x $2\pi r_{125}$). The integral on the right is a quantity of kinetic action for the quions travelling at velocity c over one core revolution ($2\pi r_{125}$).

7. Compatibility with the Standard Model

The models for an isolated proton, electron or muon given in Papers 1, 2, 3, were very successful at explaining the Yukawa-type hadronic potential, the reality of spin, anomalous magnetic moment, and particle creation mechanisms. On the other hand, the Standard Model of particle interactions has been very successful at accounting for data from high energy collision experiments. Consequently, the conceptual differences between these models can be explained if particles in collisions generate aspects not immediately apparent in static models. To link these models, our trineons in baryons and quions in mesons need to behave like up, down and strange quarks when in high energy collisions. It was shown how this can be achieved for the proton in Section 11 of Paper 1.

7.1 Mesons

For the neutral pion model described in Section 2, the quion component requires a total charge (+e) according to creation equation (2.18). So, analogous to a proton-trineon, this charge could be distributed as (+e/3) for an external field and (+2e/3) for an internal field. The charge is travelling around the meson circumference ($2\pi r_{o\pi}$) at the velocity of light and could interact with an incident particle as was seen for the proton. Thus, it could behave like an up or down quark, and the corresponding anti-quion could interact like an anti-up or anti-down quark. On average therefore, the π^o could interact with an incident particle like a mixture of u d ũ d̃ quarks.

The π^+ has an orbiting heavy-positron as in Figure 2.1. In a collision process, this positron neutralises the d, ũ quarks of π^o, so the π^+ could be viewed as an ud̃ pair. Similarly, the π^- would interact like an ũd quark pair.

Meson quark assignments describe the charges. Masses of mesons are multiples of the pionet or muonet mass, but their quion and anti-quion charges are the same as for the pion. In collisions, mesons with spin can be considered to possess spin-½ quarks

7.2 Strange quarks

Strange quarks were introduced to account for long lifetimes of some particles, and they also add more variety to the types of particles. In reality, the more massive strange particles decay *rapidly* into the long-lived lowest form, so that a strange quark does not extend the lifetime of its original particle. For example, heavy K-mesons described in Section 5 have a core which survives the initial rapid decay and becomes a tightly bound kaon with long lifetime. Allocation of charge (-e/3) to a strange quark makes $K^{\pm}$ analogous to $\pi^{\pm}$, and it also makes $\overline{K}^0$ the exact anti-particle of K^0 by way of helicity.

8. Conclusion

The quark/anti-quark singularity design of meson QCD theory has been replaced by models of mesons derived in terms of structured mass components. A Yukawa-type potential was calculated for the hadronic field. By adding a heavy-electron or positron in a tight orbit around the hadronic core, a charged pion was produced. Other mesons were found to be ordered collections of standard masses, travelling in bound orbits. Periods of these orbits were related to the mean lifetimes of their mesons through action integrals. Decay products were descended from components already existing within parent mesons, as expected for a relaxation process. This provided traceability of particles and guided the analysis. The design of strange mesons with their relatively massive core was different from the flavourless mesons. Mesons J/Ψ(1S), ϒ(1S), B_c^+, B^0, D^0, and CERN(125) were included to show how their lifetimes are functions of mass structure.

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