The impact of the quark's monopole properties on the unification of the fundamental physical forces

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Summary
It is shown that the four fundamental physical forces, i.e. weak interaction, strong interaction, electromagnetism and gravity, all have their origin in the quark as the single true elementary particle. This requires conceiving the quark as a Dirac particle in a pseudo-tachyon mode, which possesses two real dipole moments: the common one associated with its angular momentum and a second one that is polarisable in a scalar field. This Dirac particle carries a regular charge magnetic monopole without Dirac's string, theorized by Comay. The boson carrier of its field of energy is the gluon showing an exponential decay of its spatial range because of the influence of an omni-present energetic background field, known as the Higgs field, in this article interpreted as the Lambda in Einstein's Field Equation.

Keywords: grand unification; magnetic monopole; pseudo-tachyon; Higgs field

Introduction

The work to be described in this document is meant as an extension on earlier work, in which hadrons have been described in terms of quarks that are conceived as Dirac particles of a particular type (pseudo-tachyon) that possess the unique property of having a polarisable dipole moment in scalar potential field [1,2]. It has been shown and justified that the quark can be modelled as an energetic pointlike particle that erupts an energetic field $\Phi(r)$, which can generically be expressed as,

$$\Phi_F(r) = \frac{\Phi_{F0}}{\lambda r}, \tag{1}$$

in which Φ_{F0} is a strength parameter in units of energy and in which λ is a normalization parameter with dimension [m^{-1}]. The polarisable dipole moment is responsible for an additional near field that along the direction of the dipole axis has the format $\Phi_N(x)$, which can be generically be expressed as,

$$\Phi_N(x) = \frac{\Phi_{N0}}{(\lambda x)^2}. \tag{2}$$

The two fields can be combined into a single field expression. To explain the short spatial range of nuclear forces, it has been assumed that the fields are shielded by an energetic background field in a similar way as the Coulomb field of a charged particle in an ionic plasma is shielded by the Debije effect. As a result from these two contributions, the

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potential field of a quark in this background field can be generically expressed along the axis of the dipole moment as,

$$\Phi(x) = \Phi_0 \exp(-\lambda x)\{\frac{1}{(\lambda x)^2} - w\frac{1}{\lambda x}\}, \tag{3}$$

in which w is a dimensionless weighing factor that relates the far field with the near field. The identification of the background field with the Higgs field as defined in the Standard Model has enabled the assessment of a numerical value $w \approx 1/0.55$. This quark model enables to conceive the archetype meson (pion) as a structure shown in figure 1. In this structure the quark is coupled to the field of the antiquark. In the center-of-mass frame, the relativistic two-body structure can be modelled as a non-relativistic one-body a(n) harmonic oscillator that can be described by a Schrödinger type wave function ψ in the wave function equation,

$$-\frac{\hbar^2}{2m_m}\frac{d^2\psi}{dx^2} + g\Phi_0\{k_0 + k_2\lambda^2 x^2 + ...\}\psi = E\psi, \tag{4}$$

This represents an anharmonic quantum mechanical oscillator characterized by quantum steps $\hbar\omega$ related with the effective mass m_m, such that

$$\frac{1}{2}m_m\omega^2 = g\Phi_0 k_2\lambda^2 \rightarrow \frac{m'_m(\hbar\omega)^2}{(\hbar c)^2} = 2g\Phi_0 k_2\lambda^2. \tag{5}$$

Conventionally, $m'_m = m_m c^2$ is the energy of the central mass of the oscillator. In this case, the mass does not represent the individual masses of the two bodies, but it is an equivalent mass that captures the energy of the field. As usual, ω is related with the vibration energy $E_n = (n+1/2)\hbar\omega$. The dimensionless constant k_0 is a measure for the binding energy between the two bodies. The dimensionless constant k_2 is determined by the curvature of the potential in the center of mass. These values can be straightforwardly calculated from (3) as $k_0 = -1/2$ and $k_2 = 2.36$ [1].

Considering that the pion decays into a fermion via the weak interaction boson, the boson $\hbar\omega$ can be equated with the weak interaction boson. Hence,

$$\hbar\omega = \hbar\omega_W. \tag{6}$$

Its value $\hbar\omega_W$ = 80.4 GeV represents the relativistic value of the non-relativistic lab frame rest mass of the pion ($m'_\pi = m_\pi c^2 \approx$ 140 MeV).

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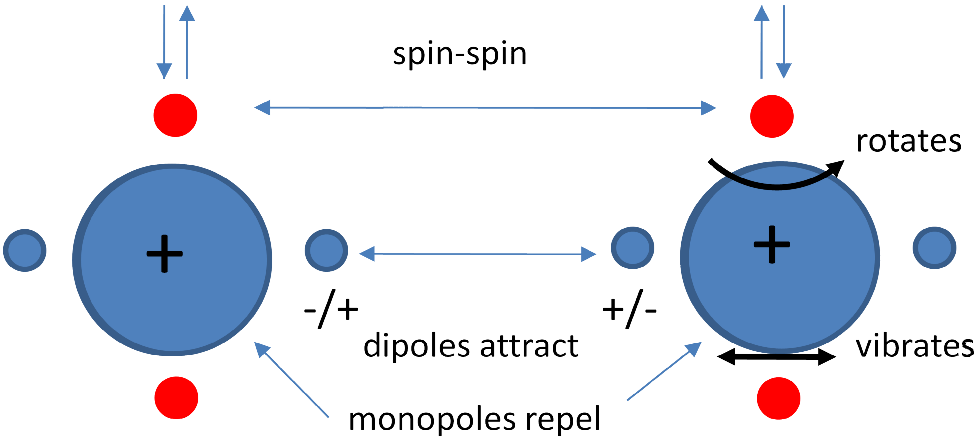

Fig. 1. A quark has two real dipole moments, hence two dipoles. One of these (horizontally visualized) is polarisable in a scalar potential field. The other one (vertically visualized) is not. The dipole moments are subject to spin statistics. However, the polarity of the horizontal one is restrained by the bond: the horizontal dipoles are only oriented in the same direction: either inward to the centre or outward from the centre.

The oscillator settles itself into minimum energy condition. This is established under a particular spacing $2d$ between the two quarks, such that $d'_{\min} = d\lambda =$ 0.853. In this condition two important relationships can be derived. These are, respectively

$$\hbar\omega_W = 2|k_0|g\Phi_0 = g\Phi_0 \tag{7}$$

$$\frac{g\Phi_0}{\lambda} = \frac{\alpha\pi(\hbar c)}{2d'_{\min}}, \tag{8}$$

in which α is a dimensionless constant of order 1, the value of which has been calculated as $\alpha \approx$ 0.69 [2]. The simple anharmonic oscillator model described by (4) enables the mass spectrum calculation of the pseudoscalar mesons as excitations from the pion state. The excitation mechanism stops beyond the bottom quark due to the loss of binding energy. The mass spectrum calculation of the vector mesons requires the inclusion of the impact of the nuclear spin shown in the upper part of figure 1. The massive energy difference ΔE between the pseudoscalar pion and the vector type sisters rho and omega has been calculated as,

$$\Delta E = Bm'_\pi \; ; \; B = \frac{7}{12}\frac{8\gamma^2}{d'_{\min}(\alpha\pi)^2} \approx 4.66 \text{ for } \gamma = 2, \tag{9}$$

in which γ is the nuclear equivalent of the gyromagnetic ratio. In this model, the role of the Higgs field is represented by the shield parameter λ. A comparison of this structural model with the Standard Model, has revealed the relationship,

$$m'_H = 2\lambda(\hbar c), \tag{10}$$

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In fact, the Higgs now shows up as the signature of two gluons rather than as an individual particle. More particularly, the gluon-quark relationship is seen as the nuclear equivalent of the photon-electron relationship. It means that the gluon should be interpreted as the boson associated with the quark's far field (1). Such boson is subject to the Proca-type wave equation,

$$\frac{1}{c^2}\frac{\partial^2 r\Phi}{\partial t^2}-\frac{\partial^2}{\partial r^2}r\Phi+\lambda^2 r\Phi=\rho_H(r,t)\,, \tag{11}$$

in which $\rho_H(r,t)$ is a Dirac-type pointlike source that can be expressed as,

$$\rho_H(r,t)=4\pi\frac{\Phi_0}{\lambda}\delta^3(r)H(t)\,, \tag{12}$$

Figure 2 shows the solution of the gluon's wave function in a graphical format. Unlike a gamma photon, the gluon is subject to dispersion. The dispersion is due to the λ^2 term in the Proca wave equation (11). This term is a consequence of the energetic ambient field, known as the Higgs field.

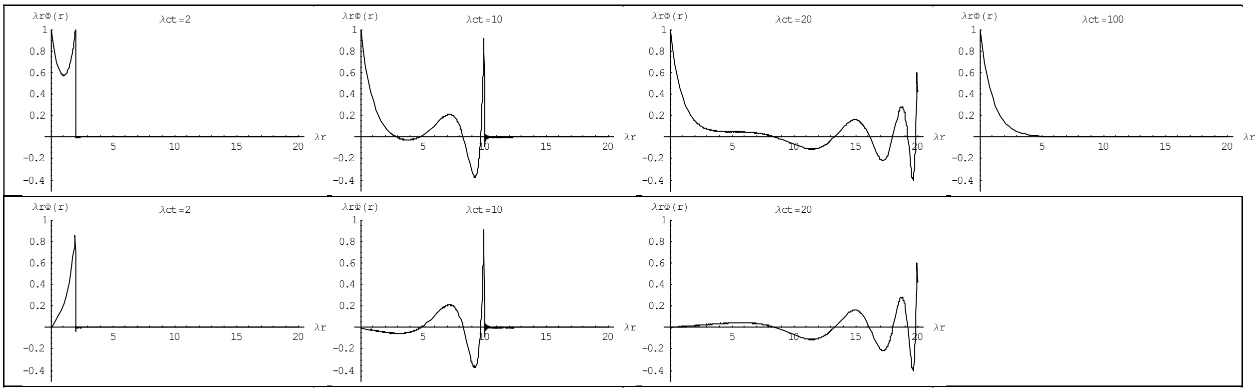

Fig.2. The building of the quark's potential field as a result of a sudden energy eruption from its source. The field is the sum of the steady solution shown at the right and the transient pulse shown in the lower part of the figure. This pulse is the actual gluon. It propagates at light speed and it eventually disappears as a result of dispersion. If λ is zero, the transient is a never disappearing gamma photon and the stationary situation is shown by an unfinished rectangular shape of the upper most right graph. Note that the field is represented by $r\Phi(r)$.

The monopole properties of the quark

So far in this description, a generic energetic potential Φ has been assigned to the quark, to which an identical other one couples with a dimensionless coupling factor g, such that the interaction force F is expressed as,

$$F=g\frac{\partial}{\partial r}\frac{\Phi_0}{r'}\,;\quad r'=r\lambda\,, \tag{13}$$

in which λ is a normalization quantity that makes r' dimensionless. Because of the degree of freedom in the invariant product $g\Phi_0$, the coupling factor g has been set to the square root of the electromagnetic fine structure constant α_e, such that $g = \sqrt{\alpha_e} = 1/\sqrt{137}$.

Doing so similarly for the interaction between two electrons, we would have,

$$F = g\frac{\partial}{\partial r}\frac{\Phi_0'}{r'} = \frac{e^2}{4\pi\varepsilon_0}\frac{\partial}{\partial r}\frac{1}{r} = \frac{e^2}{4\pi\varepsilon_0}\frac{\partial}{\partial r}\frac{\lambda}{r'} = \alpha_e \hbar c\lambda \rightarrow \Phi_0' = g(\hbar c)\lambda . \tag{14}$$

Doing so for the interaction between two unknown nuclear charges, we would have,

$$F = g\frac{\partial}{\partial r}\frac{\Phi_0}{r'} = u^2 G_{qu}\frac{\partial}{\partial r}\frac{1}{r} = u^2 G_{qu}\frac{\partial}{\partial r}\frac{\lambda}{r'} \rightarrow \Phi_0 = N_{qu} g(\hbar c)\lambda ;\ \ N_{qu} = \frac{u^2 G_{qu}}{g(\hbar c)} . \tag{15}$$

In this picture, the quantity N_{qu} is the factor that expresses the excess strength over the electrical strength. It can be calculated by comparing the far field force F_F evoked by a quark with the electromagnetic force F_e evoked by an electron e. Generally,

$$F_e = -e\frac{\partial}{\partial r}\frac{e}{4\pi\varepsilon_0 r} \quad \text{and} \quad F_F = -g\frac{\partial}{\partial r}\Phi_0\frac{\exp(-\lambda r)}{\lambda r} . \tag{16}$$

There is no reason why these forces would be the same. What is clear, however, is, that $g\Phi_0/\lambda$ plays a similar role as $e^2/(4\pi\varepsilon_0)$, i.e.,

$$\frac{e^2}{4\pi\varepsilon_0} \leftrightarrow \frac{g\Phi_0}{\lambda} . \tag{17}$$

It means that the electric force from certain electric charge q_e is equivalent with a nuclear force such that

$$\frac{q_e^2}{4\pi\varepsilon_0} = \frac{g\Phi_0}{\lambda} . \tag{18}$$

Hence, from (8) and (18),

$$q_e^2 = 4\pi\varepsilon_0 \frac{\alpha\pi\hbar c}{2d'_{\min}} = \frac{4\pi}{c^2\mu_0}\frac{\alpha\pi\hbar c}{2d'_{\min}} . \tag{19}$$

A numerical evaluation of this expression ($\alpha \approx 0.69; d'_{\min} \approx 0.856, \mu_0 = 4\pi$ x 10-7 N/A^2, e = 1.6 x 10^{-19} A s^{-1}) reveals that the far field nuclear force between two archetype quarks is about equivalent with the electric force between 13 electrons.

In a more intimate comparison between an electron and a quark we might have chosen for assigning a nuclear charge to the quark. The parallel between nuclear energy and electric energy evokes the suggestion that the nuclear energy might have an electromagnetic origin. A bold hypothesis is supposing that the quark might be a magnetic monopole q_u with an equivalent strength of 13 electrons. Considering the quark as a Dirac particle with magnetic monopole properties instead of electric monopole properties (like an electron), it must have a real electrical dipole moment, similarly as the electron has a real magnetic one.

Comay's monopole versus Dirac's monopole

Hence, let us proceed with the hypothesis that the quark is a magnetic monopole. As is well known, the magnetic monopole concept is based upon a generalization of Maxwell's equations. Let us consider the Gaussian part,

$$\nabla \cdot \mathbf{E} = \frac{\rho_e}{\varepsilon_0}; \quad \nabla \cdot \mathbf{B} = \mu_0 \rho_m , \tag{20}$$

in which ρ_e is electrical space charge and ρ_m is hypothetical magnetic space charge. Solving these equations under pointlike conditions q_e and q_m for the space charges ,

$$\rho_e = 4\pi\varepsilon_0 q_e \delta^3(r); \quad \rho_m = \frac{4\pi}{\mu_0} q_\mu \delta^3(r , \tag{21}$$

the resulting field strength expressions have the formats,

$$E = \frac{1}{4\pi\varepsilon_0}\frac{q_e}{r^2}; \quad B = \frac{\mu_0}{4\pi}\frac{q_m}{r^2} . \tag{22}$$

Whereas an "electron-type" Dirac particle with pointlike electric charge q_e has a real magnetic dipole moment $\boldsymbol{\mu}_\mathbf{m}$ and an imaginary electric dipole moment, an "electron-type" Dirac particle with pointlike magnetic charge q_m has a real electric dipole moment $\boldsymbol{\mu}_\mathbf{e}$ and an imaginary magnetic dipole moment. A (non-electron) quark-type Dirac particle, with its two real dipole moments and a nuclear charge interpreted as magnetic charge, has a real electric moment as well as a real magnetic moment. Inherited from electromagnetism, the eigen values are, respectively,

$$\mu_e = \frac{q_m}{2m_0}\hbar ; \; \mu_m = \frac{q_m}{2m_0}\frac{\hbar}{c} . \tag{23}$$

From (18) and (19), the magnetic charge is calculated as,

$$q_m^2 = \frac{4\pi}{\mu_0}\frac{\alpha\pi\hbar c}{2d'_{\min}} . \tag{24}$$

This allows the assessment of its numerical value as q_m = 6.34 x 10^{-10} A s. This value is well below the minimum value of the magnetic monopole as derived in Dirac's classic paper [3]. Dirac's monopole is constrained by the condition,

$$q_m e = n(\frac{2\pi\hbar}{\mu_0}), \tag{25}$$

in which n is a natural number. This gives a minimum value for the magnetic monopole as 3.29 x 10^{-9} A s, which is significantly larger than the calculated value for the quark. This seems to exclude the possibility that the quark is a magnetic monopole. However, it has to be taken into account that Dirac's monopole is driven by the wish to prove the quantized nature of electric charge. As pointed out by Comay [4,5,6,7] in his Regular Charge Monopole Theory (RCMT), this wish has spoiled the symmetry of Dirac's monopole theory. Dirac's theory as well as Comay's theory is is fully symmetrical under the substitutions $\mathbf{E} \rightarrow \mathbf{B}; \mathbf{B} \rightarrow -\mathbf{E}$ and $q_e \rightarrow q_m; q_m \rightarrow -q_e$. However, whereas full symmetry would require a vector potential $\mathbf{A}$ such that $\mathbf{E} = \nabla \times \mathbf{A}$, Dirac maintained $\mathbf{B} = \nabla \times \mathbf{A}$, under allowance of a string singularity. This difference makes Dirac's monopole theory asymmetrical, while Comay's monopole theory is fully symmetrical. As long as magnetic monopoles and electric monopoles (i.e. electric pointlike charges) are mutually exclusive, Comay's theory is the true equivalent of the canonical Maxwell theory. Its strength comes forward in conditions of simultaneous presence of magnetic monopoles and electric monopoles. While Dirac's monopole theory is based upon a hypothetical interaction between the two, Comay has proven that such interaction is an inconsistency by theory in the case that the interaction is supposed being taking place in static or quasi static (i.e non-accelerating) conditions. The boson fields (i.e. the radiated fields) of magnetic monopoles and electric monopoles are indistinguishable, but their fermion fields cannot interact. Because Dirac's constraint is based upon a fermionic interaction between an electron and a magnetic monopole and because such an interaction, like proven by Comay and confirmed by Mc.Donald [6], is inconsistent by theory, a magnetic monopole may still exist without being constrained by condition (25).

Let us proceed by interpreting the potential field of the quark in terms of a magnetic monopole field $\mathbf{B}(r)$ associated with, respectively, a magnetic dipole field $\mathbf{B}_d(r)$ and an electric dipole field $\mathbf{E}_d(r)$, such that,

$$\mathbf{B}(r) = \frac{\mu_0}{4\pi} q_m \frac{\hat{\mathbf{r}}}{r^2}, \tag{26a}$$

$$\mathbf{B}_d(r) = \frac{\mu_0}{4\pi} \{\frac{1}{r^3}[3(\boldsymbol{\mu}_m \cdot \hat{\mathbf{r}}) - \boldsymbol{\mu}_m] + \frac{8\pi}{3} \boldsymbol{\mu}_m \delta^3(r)\}, \tag{26b}$$

$$\mathbf{E}_d(r) = \frac{1}{4\pi\varepsilon_0} \{\frac{1}{r^3}[3(\boldsymbol{\mu}_e \cdot \hat{\mathbf{r}}) - \boldsymbol{\mu}_e] + \frac{8\pi}{3} \boldsymbol{\mu}_e \delta^3(r)\}, \tag{26c}$$

in which $\hat{\mathbf{r}}$ is the unit vector in r direction.

One may expect that the magnetic dipoles will align along the direction of the field between the two monopoles. If the quarks are magnetic monopoles, the quarks will attract, because if the quark has a positive magnetic charge, the antiquark has a negative charge. Hence, figure 2 requires a somewhat different interpretation, like shown in figure 3. This interpretation has no effect on the theory developed in [1].

The magnetic potential $\Phi_m(x)$ along the dipole axis can be written as,

$$\Phi_m(x) = -\frac{\mu_0}{4\pi}\frac{q_m}{x} + \frac{\mu_0}{4\pi}\left(\frac{q_m}{2m_0}\frac{\hbar}{c}\right)\frac{1}{x^2}. \quad (27)$$

The first right-hand term is the magnetic monopole potential and the second right-hand term is the magnetic dipole potential. The potential can be rewritten as,

$$\Phi_m(x) = \Phi_0^m\left\{\frac{1}{(\lambda x)^2} - w\frac{1}{\lambda x}\right\}, \text{ with} \quad (28)$$

$$\Phi_0^m = \frac{\mu_0}{4\pi}\left(\frac{q_m}{2m_0}\frac{\hbar}{c}\right)\lambda^2 \text{ and } w = \frac{2m_0c^2}{\hbar c\lambda}. \quad (29)$$

Equating

$$g\Phi_0 = q_m\Phi_0^m, \quad (30)$$

allows to obtain an expression for the generic potential Φ_0, such that the potential field of the quark can be read as (3), in which

$$\Phi_0 = \frac{1}{g}\frac{\mu_0}{4\pi}\frac{q_m^2\lambda}{w};\ w = \frac{2m_0c^2}{\hbar c\lambda}. \quad (31)$$

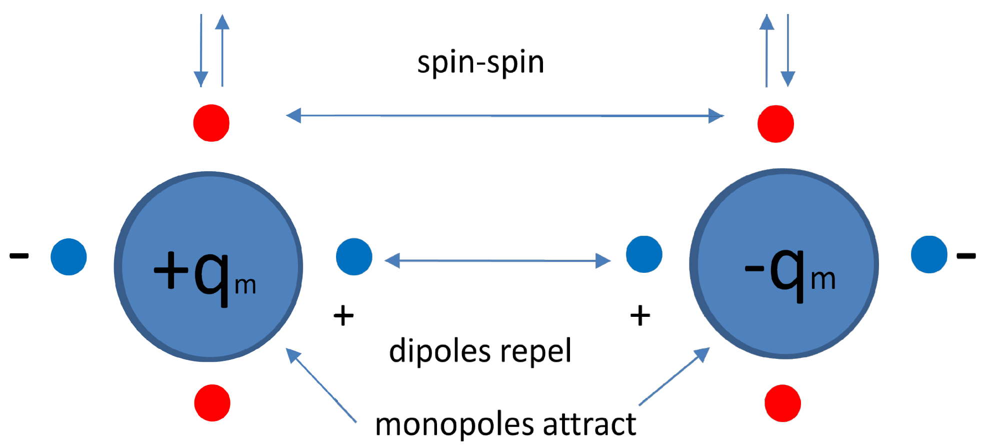

Fig. 3. Electromagnetic interpretation of figure 1.

Under consideration of (8), the magnetic charge is calculated as,

$$q_m^2 = w\frac{4\pi}{\mu_0}\left(\frac{g\Phi_0}{\lambda}\right) = w\frac{4\pi}{\mu_0}\frac{\alpha\pi\hbar c}{2d'_{\min}}. \tag{32}$$

This is slightly different from (19). This difference is due to the ignorance of the factor $\exp(-\lambda r)$ in the comparison (17). Hence, the more precise value for the magnetic charge is given by (32) instead of (19). From (32) we now have q_m = 8.54 10^{-10} A s.

Electric charge

In the analysis so far no attention has been given to the particular characteristics of the quark as a Dirac particle of a special kind. It has been shown in [1,8] that the polarisable dipole moment in a scalar field is due to a particular composition of the Dirac matrices that makes the quark different from a common massive particle, such as the electron with its positive Einsteinean energy and different as well from a particle with a negative Einsteinean energy such as the positron. Instead, the quark shows up as a particle with imaginary Einsteinean energy. It has been shown in [1,2] that the bond between two and three of those particular type Dirac particles is the cradle of baryonic energy, because the center-of-energy of the two-particle and three-particle bonds shows the characteristics of the energy-stress tensor in Einstein's Field Equation for gravity. It is an empirical fact that these bonds are electrically charged. We have also concluded that a simultaneous existence of electric monopoles and magnetic monopoles lead to theoretical inconsistencies. However, adopting the quark as a particle with an unusual energetic format, different from electrons, might give a novel view on the inconsistencies. Recognizing the correlation between isospin and electric charge and recognizing isospin as the state of the polarisable linear dipole moment of a quark, one may hypothesize that the magnetic dipole moment of the quark with its imaginary Einsteinean energy is a manifestation of the magnetic dipole moment of electric charge belonging to real Einsteinean energy. If so, the bond between the quark and the antiquark not only generates a center-of baryonic energy, but it also generates the electric charge that takes part of this baryonic energy. Figure 4 shows the concept.

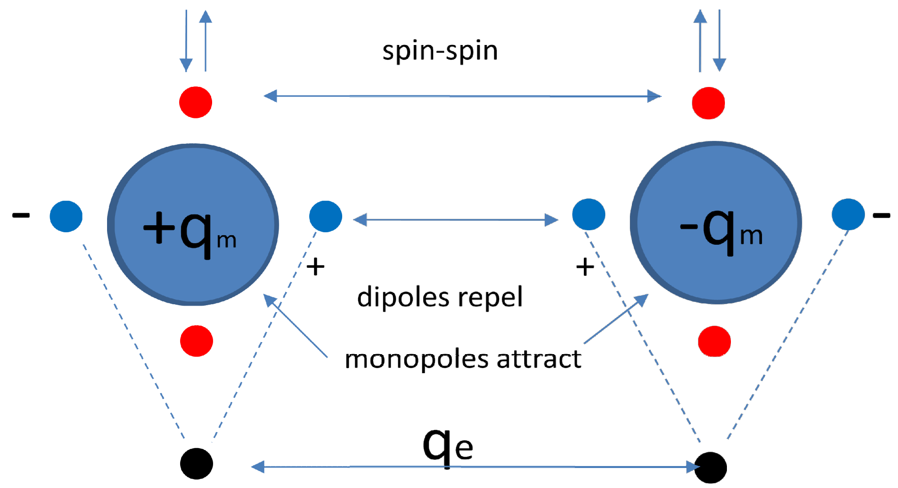

Fig.4: Hypothetical equivalence of the quark's polarisable linear dipole moment with the magnetic dipole moment of its electric charge attribute.

To investigate the hypothesis, let us equate the magnetic dipole momentum μ_m^m of a monopole q_m with unknown mass m_0 with the magnetic dipole μ_m^e of an electric charge q_e with unknown mass m_e. Hence,

$$\frac{q_m}{2m_0}\frac{\hbar}{c} = \frac{q_e}{2m_e}\hbar \rightarrow q_m = \frac{m_0}{m_e} q_e c\,. \quad (33)$$

Invoking (32) and applying it to (33) gives a relationship between m_0 and m_e

$$q_m = \frac{m_0}{m_e} q_e c = \{w \frac{4\pi}{\mu_0}\frac{\alpha\pi\hbar c}{2d'_{\min}}\}^{1/2} \rightarrow$$
$$\frac{m_0}{m_e} = \frac{1}{c}\{\frac{w}{q_e^2}\frac{4\pi\varepsilon_0}{\mu_0\varepsilon_0}\frac{\alpha\pi\hbar c}{2d'_{\min}}\}^{1/2} = \frac{e}{gq_e}(w\frac{\alpha\pi}{2d'_{\min}})^{1/2} \approx \frac{1.52}{g}\frac{e}{q_e}. \quad (34)$$

Apparently $q_e = e/2$, because the electric charge of the pion equals the elementary charge e and because this charge is composed by two contributions q_e. Under consideration of $g = 1/\sqrt{137}$ and $q_e = e/2$, the ratio $m_0/m_e \approx$ 35.6. Although calculated in the center-of-energy frame, this ratio will hold in the lab frame as well. It corresponds fairly with the ratio of the pion mass over the mass difference between the charged pion and the neutral pion, which amounts to 140/4.6 = 30.4.

It is fair to conclude that the magnetic monopoles in the pion have ("Gilbertian") magnetic dipole moments that create magnetic fields in a force balanced structure with the magnetic monopole fields, while being at the same time the "Amperian" dipole moment of kernels of electric charge. The classification "Gilbertian" and "Amperian" is from Mc. Donald [6].

Baryons

The baryon structure is more complicated than the meson structure. Nevertheless, under proper orientation of the Gilbertian dipoles a stable structure may arise, because the magnetic fields from the monopoles and the dipoles just cancel in the center-of-mass. The structure can be described as the one-body equivalent of a three-body harmonic oscillator in which the center-of-mass models the vibra-roations of the three constituting quarks. Similarly as in the case of the pion, the Gilbertian dipole moments conincide with equivalent Amperian ones that are associated with an amount of electric charge. Because the polarity of the Amperian dipole moments may assume different signs within the Pauli spin constraints, the baryon structure shown in figure 5 may assume different electric charges.

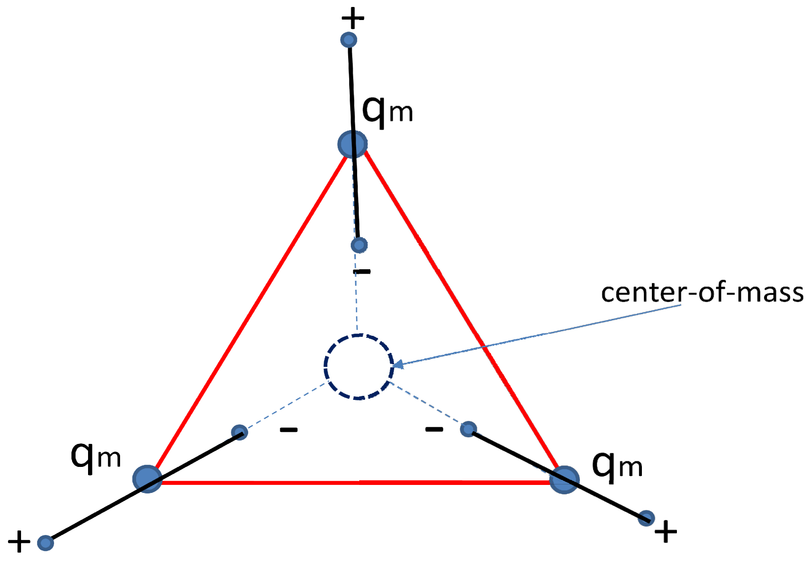

Fig.5: Basic baryon structure. The polarisable ("Gilbertian") magnetic dipole moments balance the magnetic fields of the monopoles. The vibra-rotations of the monopoles have an equivalent in the behavior of the center-of-mass. The Gllbertian dipole moments have equivalent Amperian magnetic dipole moments associated with electric charges that determine the electric behavior of the center-of-mass.

Figure 6 shows how the Gilbertian dipole moments with their fixed orientation may have different polarity Amperian manifestations. Under *nuclear* spin 1/2 condition two modes show up. These are shown in the upper part, which makes clear that the isospin condition is half spin as well. In the nuclear spin 3/2 condition four modes are possible, two of these with isospin 1/2 and two of these with isospin 3/2.

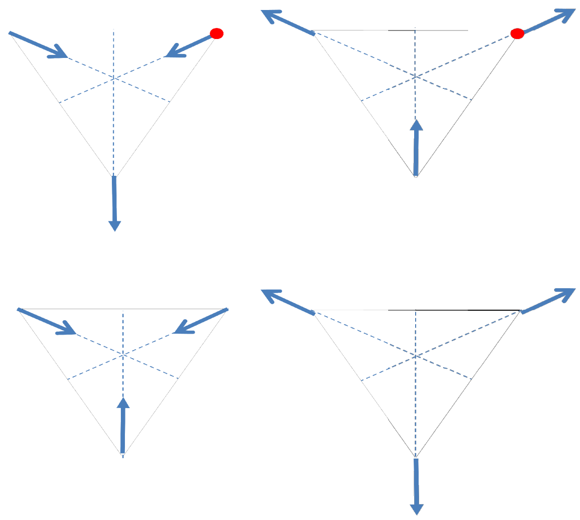

Fig.6: The basic baryon configurations. The arrows represent the isospins. The upper part holds for nuclear spin 1/2 (with dot) and for nuclear spin 3/2 (without dot). The nuclear spin 3/2 condition has two additional modes, shown in the lower part. The isospins oriented toward or outward the center-of-mass are regarded as, respectively, up spins (u) or down spins (d).

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Table

baryon	Isospin modes	code	total isospin	bias	charge	symb
$(uu)\underline{u}$	$(\uparrow\downarrow)\uparrow$	$(ud)\underline{u}$	+1/2	+1/2	1	p
	$(\uparrow\downarrow)\downarrow$	$(ud)\underline{d}$	-1/2	+1/2	0	n

baryon	isospin modes	code	total isospin	bias	charge	symb
$(uu)u$	$(\uparrow\downarrow)\uparrow$	$(ud)u$	+1/2	+1/2	1	Δ^{+}
	$(\uparrow\downarrow)\downarrow$	$(ud)d$	-1/2	+1/2	0	Δ^{0}
	$(\uparrow\uparrow)\uparrow$	$(uu)u$	+3/2	+1/2	2	Δ^{++}
	$(\downarrow\downarrow)\downarrow$	$(dd)d$	-3/2	+1/2	-1	Δ^{-}

These modes can be captured in table format as shown in the table. While the 1/2 spin configurations shown in the upper part of the table are clearly free from violations of Pauli's spin theorem, it is less clear for the 3/2 spin configurations in the lower part of the table. In the Standard Model, the perceived Pauli conflict in the 3/2 spin uuu and ddd configurations is solved by an additional theorem next to the isospin one. This additional axiomatic theorem is known as color charge. Comay [9], though, has proven that the $\Delta^{-},\Delta^{0},\Delta^{+},\Delta^{++}$ is free from spin violations.

As discussed in [1], the baryon can be modeled as a three-body harmonic oscillator. Its wave function has the format [10],

$$-\alpha_0\{\frac{d^2\psi}{d\rho'^2}+\frac{5}{\rho'}\frac{d\psi}{d\rho'}+\frac{R(m,v,k)}{\rho'^2}\psi\}+V'(\rho')=E'\psi\,,$$

in which

$$\alpha_0=\frac{\hbar^2\lambda^2}{6m_{eff}\,g\Phi_0}\,;\;E'=\frac{E}{3g\Phi_0}\,;\;V'=\frac{V}{3g\Phi_0}\,;\;\rho'=\rho\lambda\,,\text{ and}$$

$$V(\rho')=3g\Phi_0(k_0+k_2\rho'^2+.......) \tag{35}$$

$$R(m,v,k)=4m+|v-k|(4m+|v-k|+4)$$

In the ground state $m=0$. Hence,

$$R=R(0,v,k)=l(l+4)\,;\;l=|v-k|\,. \tag{36}$$

The radial variable ρ is the already mentioned hyper radius, the square of which is the sum of the squared spaces between the three bodies. The state $(m=0,l=0)$ is the ground state (nucleons and delta's). The state $(m=0, l=1)$ is the Σ state, etc. This model allows a pretty accurate calculation of the mass spectrum of baryons including higher excitations [10]. The heuristic format of the quark potential field, adopted in [10] has got a support by theory since the discovery of the polarisable linear dipole moment in a scalar field [1].

The Higgs field

An essential element in the theory developed so far is the presupposed existence of an energetic background as a cause for the spatial exponential decay of the quark's potential field. Here, we meet a parallel with cosmology, in which the existence of an energetic background field is required to explain some cosmological phenomena, such as, for instance, the accelerated expansion of the universe by "dark energy". To understand this phenomenon within Einstein's framework for gravity, established by his theory of General Relativity, the dark energy is considered as being embodied by the Lambda parameter in his Field Equation. This Lambda parameter influences the space-time curving of the universe and modifies Newton's gravity law on top of the Schwarzschild solution for $\Lambda=0$. Although far from trivial, it appears possible under particular constraints to derive from Einstein's Field Equation a meaningful wave function for the bosonic central force, such that,

$$-\frac{\partial^2}{c^2\partial t^2}(r\Phi)+\frac{\partial^2}{\partial r^2}(r\Phi)+\lambda^2(r\Phi)=-r\frac{8\pi GM}{c^2}\delta^3(r)U(t), \tag{38}$$

In which $\lambda^2=2\Lambda$.

The constraints are twofold. The first one has to with the recognition that space is not empty, but, instead behaves as a molecular fluidum in thermodynamic equilibrium. This allows removing an irrelevant bias, which, in fact, is an equivalent for renormalization as known within the context of the Standard Model of particle physics. The second element is the restriction to a spatial range of validity between a low spatial limit r_L and a high spatial limit $r_H\lambda \approx 6$. The derivation of (38) can be found in [11] (although not relevant for the derivation, it might be useful to note that in [1] the incorrect gamma set of the novel Dirac particle shown in {11] has been corrected).

Recognizing this parallel and the correspondence between (38) and (11), there is no reason why space-time curving would be restricted to common massive energy. Accepting the RCMT magnetic monopole as the ultimate energetic source, it is fair to suppose that this source curves space-time similarly as a gravitational pointlike source does. There is a difference, though, in the sign of λ^2. In fact, the theoretical derivation leaves the sign open to physical interpretation of the origin of Λ, on which Einstein's theory does not give the answer. The physical interpretation has to do with the nature of the energetic constituents that assemble the energetic background fluid. Applying in both cases Debije's model of polarisable almost mass less dipoles, the bosonic field is either enhanced or shielded. There is reason to suppose that in the gravity case the bosonic field is enhanced, because this would explain the dark matter effect in the gravitational objects orbiting in galaxies, while there is reason to suppose that in the nuclear case the bosonic field is shielded. In other words: whereas baryonic kernels are attracting on the background dipoles, the RCMT monopoles are repelling on the background dipoles.

Corollary

The four fundamental physical forces can be unified in a single theory. Essential elements of the theory are:

1. The quark is a pseudo-tachyon. i.e., an unrecognized Dirac particle that has, next to the well-known real dipole moment associated with the elementary angular momentum ***h***, a second real dipole moment associated with an elementary linear dipole moment ***h/c***, which, unlike as in the case of electrons, is polarisable in a scalar potential field. Its theory can be found in [1,8]

2. The quark is an RCMT magnetic monopole. This monopole is different from the well-known Dirac monopole, because its Maxwellian definition is different. Its theory can be found in [4].

3. Because the quark is a pseudo-tachyon as well, it has a real magnetic dipole moment. This magnetic dipole moment defines an elementary amount of electric charge associated with the quark, such as described in this article.

4. The quark's RCMT magnetic charge spreads a Coulomb-type nuclear field to which other quarks may couple with a coupling factor equal to their own magnetic charge.

5. The quark's RCMT field is shielded by a background field, known as the Higgs field. It can be conceived as an energetic plasma of tiny magnetic dipoles in a similar way as an electric charge is shielded by the polarization of electric dipoles in an ionic plasma (DeBije effect). The quark's electric field from its elementary charge is unaffected by the polarization of the energetic background field.

6. Bonds of three quarks (baryons) and quark-antiquark (bonds) behave as quantum-mechanical oscillators that convert the RCMT monopole fields of the pseudo-tachyon quarks into baryonic energy. The vibration energy of the center-of-energy is the baryonic manifestation of the non-baryonic energy of the quarks [1,2]

Conclusion

Whereas the theory developed in [1] has shown the unification between weak interaction and gravity from the concept of a single archetype quark, the unification is completed with electromagnetism and strong interaction by the hypothesis that the archetype quark is an RCMT monopole [3]. The quark is the energetic source of all four fundamental physical forces.

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