Spring 5-4-2023

Electron And Other Quarks As Particles Made Of Elementary Particles Of Charge e/3 And Mass me/6

Polievkt Perov
pperov@suffolk.edu

Electron and other quarks as particles made of elementary particles of charge e/3 and mass $m_e/6$

Polievkt Perov

Suffolk University, 8 Ashburton Pl, Boston, MA 02108

Abstract

We suggest that the first-generation quarks are not elementary particles, but structures made of a basic elementary particle of charge e/3 and its antiparticle, interacting via an electrostatic force. The structures are suggested for d-quark as consisting of one positive and two negative basic elementary charges, for u-quark as a structure with one negative and three positive basic charges, for an electron as a quark with one positive and four negative basic charges, and for one more quark made of one positive and one negative basic charge. All the suggested structures are in a spinning motion and are stable. The spins of an electron and other quarks are explained as being the quantized orbital angular momenta of the suggested structures. The mass m of the basic elementary particle had been determined as $1.52 \cdot 10^{-31}$ kg, or one-sixth of the electron mass.

Basic e/3 charge and the models of d-quark, - quark, and electron.

Quarks are very essential building blocks of matter. They are considered elementary particles with charge, spin, and magnetic moment. A review of history of quarks as particles with a fractional charge was presented by George Zweig [1], one of the authors of the concept of quarks, who originally introduced quarks as four “aces”.

In our previous working paper [2], we introduced the models of a proton and a neutron based on the electrostatic and magnetic spin moment interactions between quarks, without using a concept of strong interaction between quarks other than the electromagnetic interaction. But the question of how any particle acquires the magnetic moment was not discussed, and the values of the magnetic moments of the d and u quarks were not known because there was no experimental observation of quarks, “elementary particles”, as separate entities. An electron has a spin magnetic moment, but there is no satisfactory explanation of that fact.

Naturally, the magnetic field is considered as being produced by moving charges. We suggest four stable spinning structures for the first-generation quarks (including an electron) made of basic elementary particles with a charge of magnitude *e/3*. The mass *m* of the basic elementary particle has been determined from applying the known parameters of electron to our model of an electron as a quark. With the known mass and charge of a basic elementary charge, the properties of other quarks can be calculated.

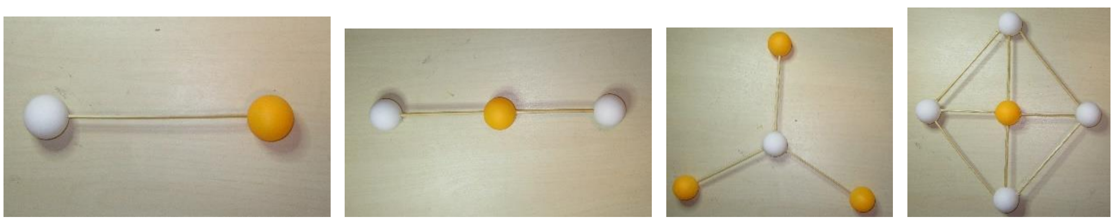
The suggested structures are made of two, three, four, and five elementary charges. The structures (quarks) are in rotation about an axis of symmetry. The net force on each basic charge is the result of its interaction with all the other charges in the structure. The net force on each charge on the axis of rotation must be zero, and the net force on each revolving charge is a centripetal force required for the circular motion. Four structures of quarks that can be in a stable dynamic equilibrium involving spinning about an axis of symmetry are:

1. Structure 1 (labeled (a) in Fig. 1): One $+{}^{e}/_{3}$ and one $-{}^{e}/_{3}$ charges, revolving about the axis through the middle point between the charges, perpendicular to the line connecting the charges (as depicted as a ball and stick model).
2. Structure 2 (d-quark) (labeled (b) in Fig. 1): One $+{}^{e}/_{3}$ charge in the center and two $-{}^{e}/_{3}$ charges at both sides from the central positive charge (ball and stick model). The structure is in spinning motion about the axis through the central charge, perpendicular to the line connecting the charges.
3. Structure 3 (u-quark) (labeled (c) in Fig. 1): One $-{}^{e}/_{3}$ charge in the center and three $+{}^{e}/_{3}$ charges positioned symmetrically around the central negative charge (shown as a trigonal plane structure).

4. Structure 4 (electron) (one variant of the structure is shown and labeled (d) in Fig. 1): One $+{}^{e}/_{3}$ charge in the center and four $-{}^{e}/_{3}$ charges positioned around the central positive basic charge. There are three possible variants of the structure: one – as a centered square with the axis of rotation normal to the plane and passing through the central positive charge; second – a tetrahedral structure (like a methane molecule), with the axis of rotation passing through two basic charges - the central positive charge and one negative basic charge; third – a rhombus rotating about its long diagonal, as shown in Fig 1, d, with the axis of rotation passing through three basic charges.

   For all the structures, the net force on each revolving charge is a central force, toward the axis of rotation. In our models, that central force is the net electrostatic force applied to that charge by all other charges in the structure.

The suggested structures are shown in Fig. 1. For all four structures, it can be shown that the symmetrical shapes cannot be stable without spinning. But with rotation, the net force on the charges that lie on the axis of rotation can be zero at definite angles in the structure, and the net attractive force on each revolving charge q is the centripetal force required for the rotational motion of a particle of mass m.



(a) (b) (c) (d)

Fig. 1. Quark models as the structures made of the basic charge and its antiparticle. (a) – a quark made of one negative basic charge and one positive basic charge; (b) – d-quark made of one positive basic charge and two negative basic charges; (c) - u-quark made of one negative and 3 positive basic charges; (d) – electron as a quark made of one positive and 4 negative basic charges. Positive basic charges are shown as orange balls, and negative basic charges are represented by white balls.

For each of four suggested quark structures, the orbital angular momentum $\vec{L}$ of the rotational motion is the spin $\vec{S}$ of that structure. The orbital angular momentum is quantized the same way as the orbital angular momentum in a hydrogen atom, $L = \sqrt{l(l+1)}\hbar$. The magnitude of the spin of a quark in its ground state is the orbital angular momentum of its corresponding structure at *l = 1*.

It was previously believed that quarks have never been observed separately from the structures consisting of them, therefore their properties were not measured directly. In our models, an electron is one of the quarks, and luckily, unlike other quarks, it has been observed separately from other structures, and its properties (including spin and magnetic moment) have been experimentally determined. Therefore, the properties of the basic charge particle as a component of quarks can be determined from the known properties of electrons as observable quarks. As a result, the properties of other quarks can be determined.

Mass of a basic particle calculated from the known magnitudes of spin and magnetic moment of an electron.

For any point charged particle of charge q and mass m, when in a rotational motion, both the angular momentum L and the magnetic moment M are related to the enclosed area of the closed loop path. Let us consider the uniform rotational motion, along a circular path.

The magnetic moment of a loop current that encloses the area *A* is defined as $M = IA$. The angular momentum L of N revolving point particles of mass m is *L = Nmvr*.

$$|M| = IA = \frac{N|q|v}{2\pi r}\pi r^2 = \frac{N|q|vr}{2} = \frac{|q|}{2m}L \quad (4)$$

Hence, for the rotational motion of identical point particles of mass m and charge q, independently on the number of particles and of the strength and nature of their interaction,

$$\frac{M}{L} = \frac{q}{2m} \quad (5)$$

The magnitudes of electron spin S and magnetic moment μ_e are known as

$$S = \sqrt{\frac{3}{4}}\hbar \quad (6)$$

$$|\mu_e| = 2.00232\left(\frac{|e|}{2m_e}\right)S \quad (7)$$

Using equation (5) and the values of the electron spin and magnetic moment known from multiple experiments, the mass of the elementary e/3 basic charge was determined as $m = 1.52 \cdot 10^{-31}$ kg, or $m_e/6$.

Conclusion

We suggested that the first-generation quarks are not elementary particles but are the structures based on an elementary basic charge q = e/3 and its antiparticle. Four structures of quarks were suggested, all being in spinning motion and stable. The mass of the basic elementary particle has been shown to be one-sixth of the electron mass. Three of the four models represent d-quark, u-quark, and electron, each having a charge, a spin angular momentum, and a magnetic moment. The electric charge and the magnetic moment of quarks are the essential sources of interactions, including any structures made of quarks, such as protons and neutrons. The fourth quark structure, made of two charges (an elementary basic charge and its antiparticle), has a spin angular momentum but does not have a magnetic moment and is electrically neutral.

It is feasible to assume that with the suggested structures, the first-generation quarks (and an electron as a quark) might be in excited states with the spin and the exited energy levels quantized, like an orbital angular momentum and the exited energy levels in hydrogen atoms.

References

1. Zweig, George, "Concrete Quarks – The Beginning OF The End". EPJ Web of Conferences, 71, 00146 (2014). 2nd International Conference on New Frontiers in Physics. https://doi.org/10.1051/epjconf/20147100146
2. Perov, Polievkt, "Proton, Neutron, and Nuclei Models Without Strong Nuclear Force" 2023. College of Art and Sciences Faculty Works. 6. https://dc.suffolk.edu/cas-faculty/6/