Helicoidal Model of the Nucleon

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Abstract

This work is an extension of the Helical Electron Model (proposed by the same author), applied to protons and neutrons.

1 Introduction

The Helical Model of the Electron [1] postulated that the electron is a unit charge point particle that orbits at the speed of light around a point in space, forming a vortex or current loop. The circular motion of the charge creates an angular momentum and its associated magnetic moment.

By analogy we assume that all subatomic particles have the same structure as the Helical Electron, differing mainly by their charge and mass. The proton and neutron follow the same model of the electron, with radius equal to its reduced Compton wavelength. Compton wavelength is inversely proportional to the mass, so subatomic particles are smaller the higher is its mass. Both the proton and the neutron are about 2,000 times smaller than the electron. This size coincides with the experiments performed by Rutherford about the atomic nucleus, which is in the order of 1 fm.

2 Radius of the nucleon

The exact value of the radius internationally accepted is 0,8768 fm. In 2010 an experiment with Muonic Hydrogen was published[2], obtaining a result of 0,8418 fm for the proton radius. The experiment was repeated in 2013 [3] increasing the resolution and ultimately obtaining a value of 0,8408 fm. This value represents a difference of 4% compared to the calculated value according to previous experiments. This difference is considered excessive and has not yet been explained. The problem is known as "proton radius puzzle".

The radius of the Helical Proton is just its reduced Compton wavelength, equivalent to 0.2103 fm

$$R = \lambda_c = \frac{\hbar}{m_p c}$$

As a curiosity, if we multiply this radius by 4, we obtain the value of 0.8412 fm, which fits perfectly with the new measurements of the radius of the proton.

3 Substructure of the nucleon

It is considered that the proton is a particle composed of other fundamental particles called quarks. It is more evident that the neutron is a composite particle as it is not stable and it has a magnetic moment with zero electric charge.

We not know how quarks are organized to form the structure of the nucleon, so we can assume a priori any geometry. As a first hypothesis we assume that the 3 quarks rotate in the same orbit equally spaced. On the Helical Electron Model, the angular momentum of a nucleon is equal to the reduced Planck constant, so the magnetic moment of the proton and neutron should be equal to a nuclear magneton:

$$\mu_N = \frac{e\hbar}{2m}$$

Experimentally we obtain quite similar values, with an anomalous magnetic moment of the proton of 2,792 and a neutron of 1,913. These slight differences between theoretical and experimental magnetic moment of nucleons are considered to be caused by the internal structure of the nucleons, consists of several quark.

An experiment performed in 1987 [4] by the European Muon Collaboration (EMC) showed that the angular momentum of the proton does not correspond to the sum of the angular moments of quarks. This problem is known as "Proton spin crisis" and is still considered one of the unsolved problems of physics.

By reverse analogy, if a nucleon is a composite particle, an electron must also be a composite particle. The hypothesis that the electron is a composite particle can explain the origin of the anomalous magnetic moment of the electron (1.001159).

4 Magnetic field of the Nucleon

Comparing the physical properties of electron and proton, they only differ in the value of the mass. The charge, speed of rotation, angular momentum and the magnetic flux through the ring are equal. Energy, mass and rotation frequency are about 2000 times greater than the electron, while the radius, the rotation period and the magnetic moment are about 2000 times smaller than the electron

The magnetic field in the center of the ring, according to the Biot Savart is:

$$B = \frac{\mu_0 I}{2R}$$

In a nucleon, the current is 2000 times the current of the electron and the radius is 2000 times lower, so we have the magnetic field at the center of the ring is about 4 million times that of the electron. We have calculated previously the magnetic field at the center of the ring of the electron and it was huge, about 4 billion of Tesla, equivalent to the magnetic field of a neutron star.

This imbalance in the values is due to the magnetic field has a dependency with the inverse cube of the distance. This implies that the magnetic field inside the ring is huge, but outside of the ring the magnetic field decays much faster than the electric field.

This asymmetric behavior of the magnetic field between short and long distances leads us to suggest that the strong and weak nuclear forces are, actually, manifestations of these huge magnetic fields at very short distances.

Following this line of reasoning, in future work we want to unify this "Helical Model of Electron and Nucleon" with two very interesting alternative theories of physics:

- Theory of Elementary Particles of Charles W. Lucas [5]. This theory postulates the existence of only two elementary ring-shaped particles. The remaining particles are formed by integrating several of these rings to form structures compatible with our Helical Model of Electron. The the main achievement of this theory is describing the decays of all subatomic particles in a consistent manner.

- The Model of Atomic Nucleus of Phillip Kanarev [6]. This model postulates that nucleons are joined together by magnetic forces and it is necessary that at least one neutron is between two protons for shielding the electric field and reducing the repulsive force between them. With these simple assumptions, Kanarev is able to propose a geometric model of all atomic nuclei showing intuitively why some nuclei are more stable than others.

5 Conclusions

The Standard Model of Particle Physics is not able to explain the main experimental values of the Proton such as its mass, radius, angular momentum or magnetic. There are inconsistencies in the theory still unresolved as the "Proton Radius Puzzle" or "Proton Spin Crisis".

Alternatively to the Standard Model, we propose to extend the Helical Model of the Electron to the Proton and Neutron. As a curiosity, the experimental value of "Proton Radius Puzzle" exactly match the radius of the Helical Proton multiplied by 4.

The existence of a huge magnetic field in the center of the rings and the existence of a possible electron substructure show a consistent line of research with other two very interesting alternatives physical theories: The Theory of Elementary Particles of Charles W. Lucas and the Model of Atomic Nucleus of Kanarev.

References

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