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Electron and proton radii are due to quantum polarization rate and the speed of light

Ray Fleming
101 E State St. #152 Ithaca NY 14850
rayrfleming@gmail.com

This paper explores the reasons for the difference in electron and proton radii. In a previous paper the author explored how electron and proton charge, spin, angular momentum, magnetic moment, and mass are all quantum field effects. Both particles behave as point-like polarizers surrounded by the polarized quantum field. Each particle's magnetic moment is due to the radius, speed of light, and electric charge. The speed of light appears because that is the maximum radial velocity for both particles. Because particle spin is a function of the polarization of the quantum field, the rate of polarization must be greater for the proton than the electron by a factor that is proportional to their radii.

1. Background

Some of the most important questions in particle theory involve understanding the structure of electrons and protons and their differences. In a previous paper the author showed that electron and proton charge, spin, angular momentum, magnetic moment, and mass are all quantum field effects.[1] Those points are summarized as follows.

Electrons and protons behave like bare point-like polarizers surrounded by the polarized quantum field. It is the polarizability of the quantum field that determines the charge rather than some amount of charge contained by particles.

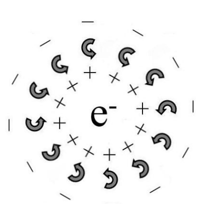

Fig. 1. Quantum dipoles rotate around an electric polarizer tending to rotate in a preferred direction in order to form the electric field with the least amount of energy expended.

Spin is also a quantum field effect. When the quantum field around a bare particle is polarized, quantum fluctuations must rotate. It takes more energy for partially polarized quantum dipoles to rotate in opposing directions than it does for them to rotate in the same direction. So, as illustrated in Figure 1, the polarization of the quantum field induces a form of rotation, even if the bare particle in the center is stationary.

Polarization induced quantum field rotation is the source of particle spin and angular momentum. Because this is a quantum field effect, spin and angular momentum are the same for different particles. As with charge, spin and angular momentum are not properties of particles.

Equation 1

$$\mu_S = g\frac{-e}{2m_e}S = -g\frac{e\lambda_e c}{8\pi}$$

Quantum field rotation gives the electron its magnetic moment ($\boldsymbol{\mu_s}$). As Equation 1 shows this is usually expressed in electron mass ($\boldsymbol{m_e}$). But to get the charge ($\boldsymbol{e}$), radius, and velocity ($\boldsymbol{c}$) needed to compute a classical magnetic moment, it is must be expressed in terms of the Compton wavelength ($\boldsymbol{\lambda_e}$). Note that the spin quanta and Planck's constant drop out of the equation. This tells us that the magnetic moment is due to a quantum field structure with the diameter of the Compton wavelength.

With the proton this approach runs into a problem. The current CODATA value for the proton's Compton wavelength is $1.321409853 \times 10^{-15}$ meters. But the proton's real diameter is twice the proton charge radius with a current CODATA value of 0.8751×10^{-15} meters. The physical diameter of the proton is 1.7502×10^{-15} meters, which is 1.3245 times larger than the proton's Compton wavelength. We must use the proton's actual diameter (***λp***) in Equation 2 for the proton's magnetic moment (μ_{sp}).

Equation 2

$$\mu_{sp} = g_p \frac{-e}{2m_p} S = -g_{pr} \frac{e \lambda_p c}{8\pi}$$

Once we make this adjustment, the proton g-factor which was g_p = 2.7928473508 times the nuclear magneton, becomes g_{pr} = 2.1086 times the proton magneton (μ_{Pr}) based on the proton's charge radius. The correction term to the proton g-factor is still larger than the correction term of the electron g-factor, due to the proton's greater self-energy. Note that small changes to the measured proton charge radius will not affect this analysis significantly.

Also, in order to perform a rotating spherical shell approximation of rotating dipoles in the field around a bare particle, we need to model it as two shells of opposite charge rotating in opposite directions. That is why the g-factor is close to two instead of one.

Then if we calculate the quantum field energy excluded by a spherical shell the size of a proton, we find that it is equal to the proton's mass.[2] The electron's mass is similarly equal to the amount of quantum field energy excluded by a Compton wavelength sized spherical shell.[2] In both cases it is assumed that the shell thickness is consistent with quantum uncertainty. Mass is not added in a particle factory and is not a property of a particle.

Electron and proton magnetic moment and mass are due to a quantum field structure at the radius of each particle. In the case of the electron the radius is half the Compton wavelength, and in the case of the proton, it is the proton's measured charge radius.

2. Origin of the Radii

The above background information does not tell us how the electron and proton come to have different radii. Given their radii appear to be entirely composed of quantum fluctuations around a bare point-like particle, we might first assume that they should have the same diameter.

We can get a clue about what is happening by recognizing the velocity used in calculating the magnetic moment in both cases is equal to the speed of light. Consequently, the maximum equatorial surface velocity, or tip speed, is the same for the electron and proton as shown in Figure 2. Tip speed increases with diameter for a given angular velocity and the effective angular velocity of the quantum shell is due to the rate of rotation in the quantum field.

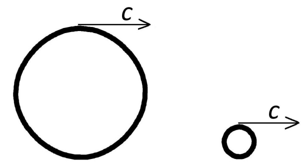

Fig. 2. Two different diameter spheres each rotating at the speed of light. (Not to scale)

That means the rate of polarization is much greater in a proton than an electron. Quantum fluctuation dipoles are polarized more strongly by a proton than an electron. The size of both particles is due to the radius where they reach the speed of light limit for their angular velocity and rate of polarization.

Even though the charges in the quantum field are not rotating along a spherical surface, it approximates a rotating spherical shell in terms of the response of the quantum field around it. Consequently, the speed of light limit is enforced by the quantum field.

3. Reason for Polarization Rate Variability

The previous information does not tell us how the electron and proton come to have different rates of polarization. It is important to note here that a proton with positive charge and matter, preferentially polarizes proton-like quantum fluctuations. Proton-like quantum fluctuations are those dipoles with positive charge and matter on one end and negative charge and antimatter on the other end. At the same time, bare electrons preferentially polarize electron-like quantum fluctuations.

To understand better, we can recall that antimatter is a negative energy solution to the Dirac equation. That means matter is a positive form of energy and antimatter is a negative form of energy. Physicists have not been clear on how to interpret this, but it obviously relates to matter and antimatter being a positive and negative charge-like property. Protons have positive electric charge and positive matter-energy, while electrons have negative electric charge and positive matter-energy.

While physicists have not traditionally considered that there would be a difference in quantum polarization between the two electric charge and matter orientations, the difference in the radii of the proton and electron indicates that there is a difference.

We actually see this in inertia and other mechanical effects.[3] No matter how one models it, inertia ends up being a form of electrically neutral self-induction. The speed of light limit is the same for electrically neutral and charged bodies, so the fundamental cause and the magnitude of the permittivity and permeability constants are the same whether a body is electrically charged of not.

In order for that to occur, a body of electrically neutral matter must be able to cause quantum field rotation with respect to matter-antimatter, while not polarizing with respect to electrical charge. Given a quantum field filled with electron-like and proton-like quantum fluctuations there must be a difference in their rate of polarization in order for a matter-magnetic field to exist in electrically neutral space. If the rates of polarization for an electron and proton where the same, the matter-magnetic field would cancel with the electromagnetic field. Thus, it is necessary that protons and electrons have different rates of polarization which leads to different radii.

4. Relative Rate of Polarization

One simple way to compare the relative rates of polarization is to determine how many times a second protons and electrons rotate. This is simply the speed of light divided by the circumference of each. For the electron that is 3.933×10^{19} rotations per second. For the proton that is 5.452×10^{22} rotations per second. The ratio is ~1386 which is the ratio of the respective radii.

The reason that value differs from the mass ratio of ~1836 is because the quantum thickness of the respective shell structures is not proportional. The reason for that difference must still be determined.

5. Neutrons

There has long been the question of how neutrons came to have their radius. A neutron forms when a bare electron enters the quantum cloud of the proton getting inside the proton's charge radius, where it stays until it later decays due to a weak interaction.

Given a simple electron-proton combination we might intuitively assume some kind of averaging of the two radii. The other idea would be either the electron or proton radius dominates for some reason. The neutron's radius is very close to the radius of the proton, showing that the structure and size of the proton is important to the neutron's size.

The quantum field around the bare positive polarizer inside a neutron still limits the size of the neutron due to its rate of polarization and the speed of light limit. It is not possible for the electron or negative charge component to establish a larger field around the neutron when the speed of light limit has already been reached.

The presence of the electron-like negative charge lowers the magnetic moment somewhat. The neutron g-factor in ($\boldsymbol{\mu_{Pr}}$) terms happens to be very close to the square root of the average of the electron ($\boldsymbol{g_e}$) and proton g-factors ($\boldsymbol{g_{pr}}$) indicating there is a simple relationship that determines the neutron's magnetic moment.

6. Conclusion

The radii of protons and electrons are due to the difference in polarization rates causing the proton to reach the speed of light limit for its equatorial rotational velocity sooner than the electron. The ratio of polarization is the same as the ratio of the particle radii, which are half the Compton wavelength for the electron and the charge radius for the proton. The proton's rate of polarization and the speed of light limit also determine the radius of the neutron.

References

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