The Riddle of the Mass of the Electron

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Abstract: The magnetomechanical anomaly for electron leads to mass of electric charge equal to half the mass of the bare electron so it must have a rich internal structure. On the other hand, the ratio of the spin magnetic moment to the orbital magnetic moment (the Bohr magneton) and the invariance of electric charge from the running fine structure constant show that only the mass is the sum of the bare mass and anomalous mass. The model of electron presented within the Scale-Symmetric Theory (SST) shows the origin of the three different masses of electric charge of electron: the quantum-loop mass is 1/2 of the bare mass of the electron, the electromagnetic mass is 3/4 of the bare mass of the electron and the SST/torus mass is 9/8 of the bare mass of the electron - the last mass is the result of the internal structure of baryons and Einstein spacetime (Es). But when we add the negative mass of the created hole in Es, which does not contribute to the half-integral spin of the charge, then mass of electric charge is always equal to the quantum-loop mass. We as well described the origin of the second half of the mass of the bare electron. Emphasize that due to the fact that the bare electron is a closed system, it transforms as a four vector. The anomalous mass is calculated in another paper as part of the very simple non-perturbative SST. Knowing the true structure of the electrons and nucleons, we can build a much more efficient energy source using a nuclear fusion but here we have not described how this device should look like - this will be described in a separate paper. Such a device differs significantly from known devices.

1. The magnetomechanical anomaly

Assume that due to a superluminal quantum entanglement, the quantum mechanics is classical and statistical i.e. the superposition and probabilities of states follow from the fact that detectors act as "subluminal" device i.e. the time of detection is much longer than the transition times and lifetimes for successive states of the system. Then the magnetomechanical anomaly and spin can be described within a classical and statistical theory. The non-perturbative Scale-Symmetric Theory is such a theory [1], [2].

Magnetic moment of a circular loop, $\mu_{spin,orbital}$ with spinning electric charge, e, with a mass of m_{charge} is

$$\mu_{spin,orbital} = m_{charge}\, v_{spin}\, r_{loop}\, e / (2\, m_{charge,spin,orbital}) = = s_{spin,orbital}\, e / (2\, m_{charge,spin,orbital}) \,, \qquad (1)$$

where $s_{spin,orbital} = m_{charge} v_{spin} r_{loop}$ is the spin/angular momentum.

For electron on the Bohr orbit ($Z = 1$, $n = 1$, $l = 0$) is

$$s_{spin} = \hbar / 2 , \quad (2)$$
$$\mu_{spin} = (\hbar / 2) [e / (2 m_{charge,spin})] , \quad (3)$$
$$s_{orbital} = \hbar , \quad (4)$$
$$\mu_{orbital} = \mu_B = \hbar [e / (2 m_{charge,orbital})] . \quad (5)$$

From (2) – (5) we obtain

$$\mu_{spin} / s_{spin} = e / (2 m_{charge,spin}) , \quad (6)$$
$$\mu_{orbital} / s_{orbital} = e / (2 m_{charge,orbital}) , \quad (7)$$

Because in mainstream physics is $m_{charge,orbital} / m_{charge,spin} \approx 1.0011596522$ so we obtain

$$(\mu_{spin} / s_{spin}) / (\mu_{orbital} / s_{orbital}) \approx 1.0011596522 . \quad (8)$$

But experiments give

$$\{(\mu_{spin} / s_{spin}) / (\mu_{orbital} / s_{orbital})\}_{\mathrm{exp.}} \approx 2 \cdot 1.0011596522 . \quad (9)$$

It is the magnetomechanical anomaly. Can we solve the problem within a classical theory? In SST, mass of the charge inside electron, $m_{charge,spin}$, is half of the bare mass of electron (it is calculated from the SST initial conditions: $m_{bare,electron} \approx 0.5104070$ MeV [2]), i.e. $m_{charge,spin} = m_{bare,electron}/2$. On the other hand, the electron on the orbit behaves as if the mass of the charge was equal to the mass of electron i.e. $m_{charge,orbital} = m_{electron}$ (mass of electron calculated within SST is $m_{electron} \approx 0.5109989$ MeV [2]). We can see that within SST we obtain

$$\{(\mu_{spin} / s_{spin}) / (\mu_{orbital} / s_{orbital})\}_{\mathrm{SST}} = 2\, m_{electron} / m_{bare,electron} \approx 2 \cdot 1.0011596522 . \quad (10)$$

$$\{\mu_{spin} / \mu_{orbital}\}_{\mathrm{SST}} = \{\mu_{spin} / \mu_B\}_{\mathrm{SST}} = m_{electron} / m_{bare,electron} \approx 1.0011596522 . \quad (11)$$

These results are consistent with experimental data.

It is claimed that we cannot explain the value (9) within non-relativistic quantum mechanics but we can see that it is untrue i.e. we can explain it within the classical-statistical SST.

Our considerations are correct on the assumption that electric charge is invariant. Now we will prove that it is true. From the invariance of charge results that only mass is a sum of mass of bare particle and of the anomalous mass which is associated with creation of the virtual electron-positron pairs (e^+e^- pairs) and exchanges of particles such as photons or the Einstein-spacetime condensates [2].

2. Invariance of electric charge

The fine structure constant at very low energy is defined as follows and is calculated within SST [2]

$$\alpha_{em,low\text{-}energy} = e^2 / (10^7\ c\ \hbar) = 1/137.0360\ . \qquad (12)$$

SST shows that at high energies we can define α_{em} as follows [2]

$$\alpha_{em,high\text{-}energy} = G_{em,electron,running}\ m_{electron}^{\ 2} / (c\ \hbar)\ , \qquad (13)$$

where $G_{em,electron,running}$ is directly proportional to density of electromagnetic field.

At very low energy, due to collisions of electrons, there are produced the electron-positron pairs plus the exchanged massless photons. It means that the relative mass density of field is directly proportional to

$$N_{low\text{-}energy} = (m_{electron} + m_{positron} + \gamma) / (2\ m_{electron}) = 1\ . \qquad (14)$$

At high energy, due to collisions of protons, there are produced the proton-antiproton pairs plus the exchanged neutral pions. It means that relative mass density of field is directly proportional to

$$N_{high\text{-}energy} = (m_{proton} + m_{antiproton} + m_{pion(o)}) / (2\ m_{proton}) = 1.07193\ . \qquad (15)$$

It means that at high energies the fine structure constant increases $N_{high\text{-}energy}$ times

$$\alpha_{em,high\text{-}energy} = \alpha_{em,low\text{-}energy}\ N_{high\text{-}energy} / N_{low\text{-}energy} = 1 / 127.84\ . \qquad (16)$$

On the other hand, experiments at high energy give [3]

$$\alpha_{em,high\text{-}energy}(\mathrm{M_Z})^{-1} = 127.944 \pm 0.014\ . \qquad (17)$$

We can see that the SST result is very close to experimental result. We received the theoretical result leaving the electric charge unchanged, which suggests that it is independent of energy.

3. The origin of the three different masses of electric charge of electron

In SST, the fundamental picture of electron is as follows. There is a loop/circle/electric-charge composed of the spinning with the speed of light in vacuum c the entangled Einstein-spacetime (Es) components – spin of the loop is half-integral and its mass is equal to half of the bare mass of electron as it follows from the magnetomechanical anomaly [2]. The second part of the bare mass of electron is the mass of the central condensate which is composed of the Es components as well. The condensate is responsible for the weak interactions of electron [2]. The loop/charge (plus sometimes a “hole” in Es) is composed of the same number of the Es components as the charge/torus $X^{+,-} = 0.3182955$ GeV inside the core of baryons so their values are the same [2]. Within the SST we calculated that the radius of the loop/charge of the bare electron is $Z_5 = 554.321$ times greater than the equatorial radius $A = 0.6974425 \cdot 10^{-15}$ m of the charge/torus $X^{+,-}$, i.e. the charge radius of electron is $\lambda\!\!\!^{-}_{bare(electron)} = A\ Z_5 = 3.8660707 \cdot 10^{-13}$ m, [2].

The listed above values of physical quantities lead to the half-integral spin of the loop/charge of the bare electron

$$(m_{bare,electron} / 2)\, c\, ƛ_{bare(electron)} = \hbar / 2 \,. \qquad (18)$$

The mass $m_{quantum\text{-}loop} = m_{bare,electron}/2$ we will call the quantum-loop mass of the electric charge of electron.

According to SST, the loop/charge of the bare electron can transform into torus in such a way that its equatorial radius is equal to $ƛ_{bare(electron)}$. Such torus is most stable when its mean radius is $2ƛ_{bare(electron)}/3$ [2]. Next, the torus/electric-charge can once more transform into loop with a radius of $2ƛ_{bare(electron)}/3$. Then we can rewrite formula (18) as follows

$$[(m_{bare,electron} / 2)(3 / 2)]\, c\, (2\, ƛ_{bare(electron)} / 3) = \hbar / 2 \,. \qquad (19)$$

Such a loop is spinning with the speed c so the mass $m_{electromagnetic} = [(m_{bare,electron}/2)(3/2)] = 3m_{bare,electron}/4$ we will call the electromagnetic mass of the electric charge of electron. We can see that $m_{bare,electron} = 4m_{electromagnetic}/3$ – it solves the $4/3$ problem that appears in the classical theory of electron. We can see that the electromagnetic mass is higher than the fundamental quantum-loop mass. It is possible because simultaneously with the electromagnetic mass there is created a “hole” in Es carrying negative mass in such a way that total mass of the charge is always equal to the quantum-loop mass. Such a virtual mass does not contribute to the half-integral spin of the charge so the half-integral spin is conserved.

Consider the electric charge as a rigid torus. Then the mean spin speed is $2c/3$ and mean radius is $2ƛ_{bare(electron)}/3$. It means that we can rewrite formula (18) as follows

$$[(m_{bare,electron} / 2)(9 / 4)](2\, c / 3)(2\, ƛ_{bare(electron)} / 3) = \hbar / 2 \,. \qquad (20)$$

The mass $m_{SST/torus} = [(m_{bare,electron}/2)(9/4)] = 9m_{bare,electron}/8$ we will call the SST/torus mass of the electric charge of electron. We can see that there must appear a “hole” in Es as well. There should be satisfied following formula

$$X^{+,-} / (9m_{bare,electron}/8) = ƛ_{bare(electron)} / A = Z_5 = 554.321 \,. \qquad (21)$$

This formula ties the masses and radii of the electric charges of proton and electron.

We can see that the bare electron, due to the created “holes” in Es, is a closed system so it transforms as a four vector.

4. Summary

Here most important is the fact that there are three different masses of the electric charge of electron: the quantum-loop mass is $1/2$ of the bare mass of electron, the electromagnetic-loop mass is $3/4$ of the bare mass of electron and the SST/torus mass is $9/8$ of the bare mass of electron. But when we add the negative mass of the created hole in the Einstein spacetime then mass of electric charge is always equal to the quantum-loop mass. The second half of the bare mass of electron is the weak mass responsible for the weak interactions of electrons. The created virtual electron-positron pair interacts with the bare electron. Such model leads to properties of electron consistent with experimental data.

Researches with real scientific power have been blocking since 1997 the correct development of theoretical particle physics and theoretical cosmology because it was at that time the theory based on the phase transitions of the inflation field, i.e. the Scale-Symmetric

Theory, was formulated. The role of quantum mechanics is overestimated especially because of the non-existing superposition of states and the renormalization which is the result of omitting the inner structure of bare fermions.

References

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