The Constructive Criticism of the Renormalization

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Abstract: Many great physicists criticized the renormalization as an incoherent method of neglecting infinities in an arbitrary way. Dirac said that renormalization "is just not sensible mathematics". Here, applying the Scale-Symmetric Theory (SST), we proved that the mainstream QED is incomplete and is based on a few wrong assumptions. QED leads to experimental data only due to the free parameters. It is not true that there is not upper limit (cutoff) for energy of virtual pairs and it is not true that bare particles are sizeless. The elimination of these two wrong assumptions causes that the modified QED (MQED) is very simple and free from infinities so from renormalization as well. In reality, an electron-positron pair at first appears as a binary system of loops with condensates in their centres both composed of entangled Einstein-spacetime components. Next, due to the superluminal quantum entanglement of the luminal Einstein-spacetime components, the binary system immediately transforms into binary system of tori/electric-charges. With each torus/electric-charge is associated loop, condensate responsible for weak interactions and only one virtual electron-positron pair. Due to the superluminal quantum entanglement, electron disappears in one place and appears in another one, and so on - it is the quantum behaviour of electron. Most important is the fact that both descriptions of magnetic moment and spin of an electron, i.e. via the initial loop plus condensate and via the torus/electric-charge plus loop plus condensate plus virtual pair, are equivalent. Both descriptions lead to the same ratio of magnetic moment of electron to Bohr magneton: 1.0011596521735. This result is very close to experimental data.

1. Introduction and motivation

In quantum theory of fields (QTFs) renormalization is a set of techniques to eliminate infinities arising in calculated physical quantities. Renormalization was first used in quantum electrodynamics (QED). There appears the mathematical indeterminate form $\infty - \infty$ so to eliminate the divergences there is introduced a method known as regularization. An arbitrary modification to eliminate infinities we call the cutoff. In the zeta function regularization there appear counterparts to get finite results.

It is obvious that theories containing renormalization are mathematically incoherent. Many great physicists criticized the renormalization. For example, Dirac in 1975 said as follows [1]: "I must say that I am very dissatisfied with the situation, because, this so-called good theories

does involve neglecting infinities which appear in its equations, neglecting them in an arbitrary way. This is just not sensible mathematics."

What we should do to formulate theory free from infinities so from renormalization as well?

In a complete theory, renormalization should not appear. The Scale-Symmetric Theory (SST) is the lacking part of the mainstream theories [2]. This theory is the superior theory to the mainstream theories in initial conditions. When we take into account the SST then infinities do not appear so theories are much simpler. The modified QED described within SST, we will refer to as MQED.

Most important is the fact that due to the succeeding phase transitions of the superluminal non-gravitating Higgs field and due to the superluminal quantum entanglement, there is obligatory the conservation of axial massive currents – they are the closed fifth dimensions in the KK theories. For example, the internal structure of the luminal gravitating Einstein spacetime and the quantum entanglement both lead to the conservation of massive electric currents in protons and electrons.

In QTFs, it is assumed that positive and negative masses of virtual particles can be arbitrary. But it is not true because to create a virtual pair in a field of a real particle is needed positive energy. This positive energy is the positive radiation mass. Positive radiation mass of a real particle is a result of interactions of the real particle with virtual pairs. Virtual pairs are created from entangled Einstein-spacetime components and mean mass density of such pairs and local mass density of the Einstein spacetime is the same as the mean global mass density of the Einstein spacetime. In reality, to create a particle carrying mass M is needed vortex of massless/non-gravitating energy E which is equal to M, i.e. the total energy of the vortex is $M + E = 2E$ [2A]. SST shows that the ground state of the Einstein spacetime is invariant in a cosmic scale. It suggests that involved virtual energy (more precisely, the sum of absolute energies of components of all virtual pairs) cannot be greater than the real energy equal to $2E$. We can see that, for example, in electromagnetic field of a real bare electron can be created only one virtual electron-positron pair. We can see that in SST, the characteristic energy scale (the cutoff) concerns the virtual pairs. SST shows as well that size of electric charge is not equal to zero so energy of its electromagnetic field is finite i.e. the cutoff concerns this field as well.

The cutoff described within the SST shows that in the MQED there should be only one diagram in which appears only one virtual electron-positron pair interacting electromagnetically and weakly with real bare electron.

We can see that in the mainstream QEC there is the next wrong assumption i.e. that bare electron is a mathematical point. It causes that there appear infinities and we must apply the mathematical indeterminate form which is characteristic for the renormalization. To eliminate this incoherence of mainstream QED we must decipher the internal structure of the Einstein spacetime and structures of bare particles. Such structures follow from the succeeding phase transitions of the superluminal non-gravitating Higgs field [2A].

Within SST is showed that to create an electron-positron pair there at first appears the binary system of loops composed of entangled Einstein-spacetime components with condensates in their centres. Such binary system has unitary spin. The loops in a binary system have the half-integral spins and opposite internal helicities. Initial radius of the binary system is equal to the reduced Compton length of single bare electron, $\lambda\!\!\!^{-}_{C,bare\text{-}electron} = 3.8660707 \cdot 10^{-13}$ m [2A]. It follows from the fact that masses of the two loops and two condensates are the same whereas the spin speeds of the loops are equal to the speed of light in "vacuum" c, i.e. $2(m_{bare\text{-}electron})/2)\, c\, \lambda\!\!\!^{-}_{C,bare\text{-}electron} = \hbar$.

Each loop plus condensate transforms into torus/electric-charge (it is only polarized Einstein spacetime; the lines of electric forces cross the circle inside torus and radius of the circle is

$2\lambda\!\!\!^{-}_{C,bare\text{-}electron}/3$ [2A]), plus loop overlapping with the equator of the torus (it is the electromagnetic mass of the electric charge), plus condensate in its centre responsible for the weak interactions and plus only one virtual electron-positron pair. Masses of the condensate and loop are the same. External radius of the torus is $\lambda\!\!\!^{-}_{C,bare\text{-}electron}$. We can see that outside the bare electron (torus plus loop plus condensate), there appears only one virtual electron-positron pair. The pair is polarized in such a way that the direction of the electric dipole crosses the circle inside the torus. Both the bare particle and virtual pair disappear in one place and appear in another one, and so on – it is the quantum behaviour of electron. Such model leads to following ratio of magnetic moment of electron to Bohr magneton: 1.0011596521735 [2A] – it is very close to experimental data.

The weak interactions of electrons in MQED, which are neglected in QED, are very important in cosmology, particle physics and atomic physics. SST shows that the electrons are entangled with protons and the dark matter (it is the long-distance quantum entanglement) [1A]. The coupling constant of the weak interactions of electrons ($\alpha'_{weak(electron\text{-}proton)} = 1.11944\cdot10^{-5}$) defines the mean amplitude of temperature fluctuations in CMB, [1B], and leads to the Lamb-Retherford Shift [2A]. Due to the coupling constant of weak interactions of electrons, we can formulate very simple theory of the hydrogen atom which is equivalent to the Dirac and Sommerfeld theories [3], and so on. All calculations are very simple and free from infinities.

But most important is whether both descriptions of magnetic moment and spin of an electron, i.e. via the initial loop plus condensate and via torus plus loop plus condensate plus virtual pair, are equivalent.

The definition of magnetic moment of electron loop is

$$\mu = I\,S = e\,S / t = e\,\pi\,r^2 / (2\,\pi\,r / c) = e\,c\,r / 2 = e\,c\,\lambda\!\!\!^{-}_{C,bare\text{-}electron} / 2. \qquad (1)$$

Within SST, we proved that $\lambda\!\!\!^{-}_{C,bare\text{-}electron} = f\,A$, where $f = 554.32108\ldots$, [2A], whereas $A = 0.6974424\ldots$ fm is the external radius of torus/electric-charge inside the core of baryons so of proton as well [2A]. We can rewrite formula (1) as follows

$$\mu = e\,c\,f\,A / 2 = 9.28476314\cdot10^{-24}\ \mathrm{J\ T^{-1}}. \qquad (2a)$$

This result obtained within MQED is very close to experimental data [4]:

$$\mu_{exp} = 9.28476430(21)\cdot10^{-24}\ \mathrm{J\ T^{-1}}. \qquad (2b)$$

Let us calculate the ratio of magnetic moment of the electron loop and Bohr magneton

$$\mu / \mu_B = (e\,c\,f\,A / 2) / (e\,\hbar / 2\,m_{electron}) = c\,f\,A\,m_{electron} / \hbar = 1.0011596521735. \qquad (3a)$$

This result obtained within MQED is very close to experimental data [4]:

$$(\mu / \mu_B)_{exp} = 1.00115965218076(27). \qquad (3b)$$

Within both descriptions of magnetic moment and spin of an electron, i.e. via the initial loop plus condensate and via the torus/electric-charge plus loop plus condensate and plus one virtual electron-positron pair, we obtained the same results so the descriptions are equivalent.

2. Summary

Many great physicists criticized the renormalization as an incoherent method of neglecting infinities in an arbitrary way. Dirac said that renormalization “is just not sensible mathematics”.

Here, applying the Scale-Symmetric Theory (SST), we proved that the mainstream QED is incomplete and is based on a few wrong assumptions. QED leads to experimental data only due to the free parameters. It is not true that there is not upper limit (cutoff) for energy of virtual pairs and it is not true that bare particles are sizeless. The elimination of these two wrong assumptions causes that the modified QED (MQED) is very simple and free from infinities so from renormalization as well.

In reality, an electron-positron pair at first appears as a binary system of loops with condensates in their centres both composed of entangled Einstein-spacetime components. Next, due to the superluminal quantum entanglement of the luminal Einstein-spacetime components, the binary system immediately transforms into binary system of tori/electric-charges. With each torus/electric-charge is associated loop, condensate responsible for weak interactions and only one virtual electron-positron pair. Due to the superluminal quantum entanglement, electron disappears in one place and appears in another one, and so on – it is the quantum behaviour of electron. Most important is the fact that both descriptions of magnetic moment and spin of an electron, i.e. via the initial loop plus condensate and via the torus/electric-charge plus loop plus condensate plus virtual pair, are equivalent. Both descriptions lead to the same ratio of magnetic moment of electron to Bohr magneton: 1.0011596521735. This result is very close to experimental data.

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