ON THE ELECTRON MASS

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Among many formulations of "finite" quantum electrodynamics (QE) (without ultraviolet divergences) it is QE of Johnson et al. which deserves special interest. This QE requires as necessary conditions for "finiteness" that the bare electron mass is equal zero[1] and that the bare electron charge is a positive finite solution of certain equation[2]. The possibility of physical electron mass and charge determination from the theory itself makes this theory very attractive.

In order to draw a conclusion about existence of a solution which would give the full electron mass from interaction a preliminary analysis of the Dyson-Schwinger equation for the electron propagator in the first nontrivial approximation has been carried out in this contribution. Searching of the Green function (GF)

$$S(p^2) = \frac{\alpha(p^2)-\hat{p}}{\alpha^2(p^2)+p^2}$$

reduces to the looking for solutions of a nonlinear integral equation or of the equivalent second-order differential boundary value problem

$$(x\alpha)'' = -g^2 \frac{\alpha}{\alpha^2 + x} \qquad x^2\alpha' \underset{x \to 0}{\to} 0 \qquad (x\alpha)' \underset{x \to \infty}{\to} 0$$

where $x=p^2=\vec{p}^2-p_o^2$ and $g^2=3/4\pi \cdot e_o^2/4\pi$. Then the finite unrenormalized electron mass would correspond to GF singularity in the timelike momentum region. In fact, we were looking for GF singularity supposing that $\alpha(x)$ is analytic function on real axis x. It is not difficult to see, that in such case, there are no singularities in above GF. Then it follows, that only a more detailed investigation of $\alpha(x)$ properties can give definite answer on the possibility of electromagnetic electron mass origin in framework of this QE.

References

1. K.Johnson, M.Baker and R.Willey, Phys.Rev. 136 (1964) B1111.
2. K.Johnson, R.Willey and M.Baker, Phys.Rev. 163 (1967) 1699.