Self-consistent renormalization. New relations between finite bare and physical masses of the electron in QED

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Abstract

The self-consistent renormalization (SCR), developed by the author previously, provides the highly efficient means for: 1) the nontraditional treatment of the renormalization theory problems associated with symmetries, Ward identities, reduction identities, and quantum anomalies; 2) the new consideration of unambiguous relations between finite bare and finite physical parameters of quantum field theories. With the use of SCR this general idea is illustrated for the electron self-energy problem in the n-dimensional QED with an arbitrary parameter $a \geq 0$ of the Lorenz covariant gauge fixing. Estimates of a solution to the equation relating finite bare, $m_0 > 0$, and physical, m, electron masses show that its electromagnetic mass, $\delta m := m - m_0$, for small $e^2 = \alpha \approx 1/137$ in the 4-dimensional QED with metric, $(p, q) = (1, 3)$, and the Landau gauge, $a = 0$, is given by $\delta m \approx (3e^2/16\pi^2)\, m_0 = \frac{3e^2/16\pi^2}{1+3e^2/16\pi^2}\, m$; so, $m/m_0 \approx 1 + 3e^2/16\pi^2$. The distinction between the chiral case, $m_0 = 0$, and the chiral limit case, $m_0 \to 0$, is investigated as well.