What is electron?

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Electron is believed to be a point-like elementary particle, which carries the negative electric charge *e* ($\simeq$ -1.602×10^{-19} C), the rest mass *m* ($\simeq 9.109\times10^{-28}$ g), and the intrinsic angular momentum, spin $\frac{1}{2}\hbar$. In this lecture, we are going to review those fundamental quantities of electron in terms of quantum field theory in the context of the Standard Model. A brief historical review and a concise explanation of the principles of relativistic quantum dynamics will be given before we discuss those fundamental properties. We will see the Lorentz invariance of the anticommuting fields leads the existence of spins and the subsequent quests for obtaining the classic quantum electrodynamic theory by Feyman, Schwinger, Tomonaga, and Dyson, leaving behind the origin of the charge and the mass of electron through the renormalization technique. The observed value of the electron charge were later understood as the consequence of a kind of phase transitions in terms of the Callan-Symanzik renormalization group equation, which is derived by making use of the Kadanoff-Wilson-Kogut scaling theory, inspired from the scaling hypothesis to the renormalization in quantum electrodynamics by Gell-Mann and Low. This renormalization group idea brought us the Standard Model, an *ad hoc* theory of the fundamental matter particles (quarks and leptons) and their interaction particles (photons, gluons, and weak bosons) by incorporating the Yang-Mills non-Abelian gauge theory. The existence of the observed masses of those elementary particles is now understood as the Goldstone-Anderson type Higgs symmetry breaking mechanism. We will see such spontaneous symmetry breaking idea to let us understand the unification concept from the Weinberg-Salam-Glashow electroweak theory to the Grand Unification Theory. We will conclude this lecture by a short comment of the many-body aspects of the electron theory.