Calculatons of the Electron Radius

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Abstract

Equating the Rest Mass Energy of a free electron to its Rest Charge Energy we prove that the electron cannot be a dimensionless point particle because if it were dimensionless, it would contain an infinite amount of Rest Charge Energy at the location of its charge since $r = 0$ gives $q^2/(24\pi\epsilon_0 r) = infinity$, which is clearly not possible. Since the electron has no internal structure, equating its Rest Mass Energy to its Rest Charge Energy, we calculate the electron to be a sphere of radius 4.68×10^{-16} meters. We calculate the Electric Field at the surface of the electron due to its charge and the Repulsive Force two electrons in proximity exert on each other.

Keywords

Rest Mass Energy, Rest Charge Energy, Size of an Electron, Electric Field, Force Exerted by Two Electrons

1. Main Text

Which one is more fundamental Mass or Charge since Mass dominates on a macroscopic level while Charge dominates on a microscopic level? According to Einstein Mass was more fundamental because Mass and Energy could be used interchangeably. He did not mention Charge even though the connection between Energy and Charge can be derived from his Special Theory of Relativity and the theory of Electromagnetism because the relationship between Electromagnetic Field Energy and Charge had not been published until recently [1]. Both Mass and Charge are equally fundamental, therefore the Rest Mass Energy of a free electron can be equated to its Rest Charge Energy since an electron has no internal structure, quite different from a proton and a neutron for which their internal structure made of up and down quarks and gluons that confine the quarks within the nucleon would have to be considered to calculate the size of the nucleons. Since quarks have no internal structure like electrons, they too

have a three-dimensional spherical size like electrons do. The sum of the size of the three quarks (up, up, down for protons; and up, down, down for neutrons) and the maximum distance they can travel within the nucleon while being bound by the gluons would give the size of the nucleon. While there is no Binding Energy to be considered for a free electron since it has no internal structure, Binding Energy by the gluons is 99% of the Mass of Nucleons and hence cannot be ignored. The Color Force between two quarks due to gluons would have to be known mathematically which makes it a much more difficult problem in QCD (Quantum Chromodynamics) and will not be considered here in greater detail.

For an electron at rest its Rest Mass Energy is given by $m_0 c^2$ and its Rest Charge Energy is given by $q^2 / (24\pi\epsilon_0 r)$ which would become infinite as its radius r becomes zero. Hence the electron cannot be a dimensionless point particle but must have a finite size. Its size must be smaller than the Bohr Radius (5.29×10^{-11} m) and the Electron Compton Wavelength (2.43×10^{-12} m). By equating the electron's Rest Mass Energy to its Rest Charge Energy we get the value of the electron radius $r_e = e^2 / (24\pi\epsilon_0 m_0 c^2) = 4.68 \times 10^{-16}$ m which better explains its spin about an axis through its spherical center, much better than stating that electrons are dimensionless point particles that have intrinsic angular momentum without being properly able to define what the term intrinsic angular momentum refers to.

The Rest Charge Energy at the surface of the electron $e^2 / (24\pi\epsilon_0 r_e)$ with $e = 1.6 \times 10^{-19}$ C equals 8.2×10^{-14} Joules.

The Electric Field $E = ke/r_e^2$ at the surface of the electron with $k = 9 \times 10^9$ Nm^2/C^2 equals 6.57×10^{21} N/C.

The Repulsive Force between two electrons touching each other $F = ke^2/r^2$ where $r = 9.36 \times 10^{-16}$ m is the distance between the centers of the two electrons equals 263 Newtons.

The Repulsive Force Between two electrons separated by a distance equal to the Bohr Radius equals 8.23×10^{-8} Newtons and separated by 1 cm equals 2.36×10^{-24} Newtons.

2. Conclusion

Only one reference was necessary for this paper since all other information contained in it can be found in a College Physics Textbook inside which can be added another Constant of Nature: Electron Radius $r_e = 4.68 \times 10^{-16}$ m.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Irani, A. (2021) Matter-Antimatter Annihilation. *Journal of High Energy Physics, Gravitation and Cosmology*, **7**, 474-477.
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