Spontaneous Symmetry Breaking

Electron mass, charge and magnetic moment

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Introduction

Period doubling is a common property of nonlinear dynamical systems. It has been suggested earlier [1 and references therein] that *period doubling* may take place in processes involving *1/r* – type potential.

Period doubling bifurcation is a bifurcation in which the system switches to a new behavior with twice the period of the original system.

Process like this is generally called *spontaneous symmetry breaking*.

1. Ari Lehto, On the Planck Scale and Properties of Matter, Nonlinear Dynamics Volume 55, Number 3, 279-298, February, 2009

Introduction

Symmetry breaking in physics describes a phenomenon where (infinitesimally) small fluctuations acting on a system which is crossing a critical point decide the system's fate, by determining which branch of a *bifurcation* is taken. To an outside observer unaware of the fluctuations (or "noise"), the choice will appear arbitrary. This process is called symmetry "breaking", because such transitions usually bring the system from a disorderly state into one of two definite states. Symmetry breaking is supposed to play a major role in pattern formation.

This is called *spontaneous symmetry breaking*, if the laws describing the system are invariant.

Source: http://en.wikipedia.org/wiki/Symmetry_breaking (August 2012)

Introduction

If the Planck time is chosen as the reference period, then the corresponding Planck mass is the reference mass. Period doubling simply means halving energies ($E=h/period$) and corresponding masses ($m=h/(period \cdot c^2)$).

After a certain number of period doublings the rest mass of the electron-positron pair is achieved, as shown in [1].

If the Planck charge is chosen as reference, then the value of the elementary electric charge can be calculated using the same principle.

Finally the elementary charge and the Planck length determine the magnetic moment of the electron.

Electron properties

Electron rest mass

Reference: Planck mass = $m_{Planck} = \sqrt{\dfrac{hc}{G}} = 5.46 \cdot 10^{-8}\ kg$

The electron-positron pair rest mass is obtained from the Planck mass after total of 224 period doublings in *three degrees of freedom*:

$$2 \cdot 9.11 \cdot 10^{-31}\ kg = 2^{-\frac{32+64+128}{3}} m_{Planck}$$

Total of 224=32+64+128 period doublings means 2^5, 2^6 and 2^7 doublings in each three degrees of freedom respectively.

Details of the calculation can be found in [1].

Elementary electric charge

Reference: Planck charge = $q_{Planck} = \sqrt{4\pi\varepsilon_o hc} = 4.701 \cdot 10^{-18}\ As$

The Coulomb energy at the Planck distance of the elementary electric charge is obtained from the Planck charge q_{Planck} squared after total of 39 period doublings in *four degrees of freedom*:

$$e^2 = 2^{-\frac{1+2+4+32}{4}} q^2{}_{Planck}$$

One obtains $e = 1.602 \cdot 10^{-19}\ As$ for the elementary charge. Total of 39 period doublings means 2^0, 2^1, 2^2 and 2^5 doublings in each four degrees of freedom respectively.

Details of the calculation can be found in [1].

Magnetic moment

Reference: Planck scale magnetic moment μ_{Planck}

$$\mu_{Planck} = \frac{ec^2\tau_o}{4\pi} = 1.5485 \cdot 10^{-46}\ Am^2$$

After total of 224 period doublings (2^5, 2^6 and 2^7) one obtains

$$\mu_{ep} = 2^{\frac{32+64+128}{3}} \cdot \frac{ec^2\tau_o}{4\pi} = 4.643 \cdot 10^{-24}\ Am^2$$

corresponding to electron-positron pair. One more doubling yields the experimental electron (or positron) magnetic moment

$$\mu_e = 9.286 \cdot 10^{-24}\ Am^2$$

τ_o is the Planck time (period). Details of the calculation can be found in [1].

Summary

It is demonstrated that *spontaneous symmetry breaking* may provide us with a mechanism for assigning mass, electric charge and magnetic moment to the electron starting from the corresponding Planck scale units. No specific fields are required.

The process is period doubling in nonlinear dynamical systems. It is assumed here that the nonlinearity is due to the *1/r* type potential and its gradient.

Three degrees of freedom are needed for mass and four for the elementary charge.

Thank you!