The Root-Mean-Square Charge Radius of Proton

Sylwester Kornowski

Abstract: Within the Everlasting Theory I calculated the charge radius of proton for experiment involving a proton and an electron 0.87673 fm, and for experiment involving a proton and a negatively-charged muon 0.84282 fm. The first result overlaps with the central value obtained in experiment (!) whereas the second is only 0.04% above the upper limit defined by experiment. The two different experimental results lead to the atom-like structure of protons.

1. Introduction

This Introduction follows from the Everlasting Theory presented here [1]. The phase transitions of the Newtonian spacetime (it is the modified Higgs field composed of the gravitationally massless tachyons; they have the inertial mass only) lead to the internal structure of the core of baryons so of the protons as well. It consists of the torus that is the electric/strong charge of the proton, and ball in its centre that is responsible for the weak interactions. The total mass of the core is $M_{core-of-baryons}$ = 727.44 MeV whereas the maximum radius of the torus is A = 0.6974425 fm. Outside the core is valid the Titius-Bode law for the strong interactions $R_d = A + dB$, where B = 0.5018395 fm and d = 0, 1, 2, 4. Inside the proton, there is the relativistic pion in the d = 1 state and mass of the relativistic charged pion is $M_{relativistic-charged-pion}$ = 215.760 MeV.

The core of baryons is created from loop that radius is A, and such loop has mass equal to $M_{core-of-baryons}$. Due to the weak interactions, inside the baryons appear the spokes that can transform into loops. If length of a spoke is L then radius of the loop is $R_{loop} = L/(2\pi)$. Mass of a loop is directly proportional to its radius and for L = A is $M_{core-of-baryons}$ = 727.44 MeV.

2. Calculations

We can assume that in approximation the volume of a free proton is the volume of the cylinder that radius of the circle/base is C = A + B. Since the smallest radius of the torus is A/3 [1] so the height of the cylinder is D = 2A/3 = 0.464962 fm. The volume of the cylinder is $\pi C^2 D$. Comparing the volume of a free proton with volume of a sphere $4\pi R^3/3$, we obtain

$$R^3 = 3C^2D/4. \qquad (1)$$

When protons interact then the created pairs of loops appear mostly in the d = 1 state as the charge-anticharge pairs. We can see that in the d = 1 state is created charged cloud composed of the pairs. This cloud increases the radius C of the interacting proton. The modified radius is $C' = C + R_{loop}$. This means that the modified radius R' can be calculated from following formula

$$(R')^3 = 3(C')^2D/4. \qquad (2)$$

For loop created from the radius of the core A is

$$M_{loop\text{-}A} = M_{core\text{-}of\text{-}baryons}/(2\pi) = 115.78\ \mathrm{MeV}. \quad (3)$$

This mass is close to the mass of the muon and probability of creation of such loops is higher than the loops corresponding to the mass of muon. This follows from the fact that the structure of the core of baryons dominates in the interactions of baryons. It means that for muon interacting with proton we obtain

$$R_{loop\text{-}muon} = A/(2\pi) = 0.1110014\ \mathrm{fm}. \quad (4)$$

Now we can calculate the root-mean-square charge radii of protons, which should be equal to R', for different initial conditions. For protons interacting with muons we obtain $C'_{proton\text{-}muon} = 1.31028$ fm so **$R'_{proton\text{-}muon}$ = 0.84282 fm** and this radius is only 0.037% above the upper limit defined in following experiment [2].

The electrons interact with the most distant electric charge i.e. with the relativistic charged pion in the d = 1 state. Radius of orbit for such pion is C = A + B. This means that there are produced loops that radius is

$$R_{loop\text{-}electron} = (A + B)/(2\pi) = 0.1908717\ \mathrm{fm}. \quad (5)$$

For protons interacting with electrons we obtain $C'_{proton\text{-}electron} = 1.390154$ fm. This leads to **$R'_{proton\text{-}electron}$ = 0.87673 fm** and this radius is the central value (!) obtained in following experiment [3].

3. Summary

Within the Everlasting Theory I calculated the charge radius of proton for experiment involving a proton and an electron 0.87673 fm, and for experiment involving a proton and a negatively-charged muon 0.84282 fm. The first result overlaps with the central value obtained in experiment (!) whereas the second is only 0.037% above the upper limit defined by experiment.

We obtained the theoretical results consistent with the two experimental results for the distances A, and A + B. We can see that the two different experimental results lead to the atom-like structure of protons.

References

[1] S. Kornowski (2012). “The Everlasting Theory and Special Number Theory”. http://www.rxiv.org/abs/1203.0021 [v2].

[2] http://www.azonano.com/news.aspx?newsID=18428

[3] Randolf Pohl, Aldo Antognini, François Nez, Fernando D. Amaro, François Biraben, Joao M. R. Cardoso, Daniel S. Covita, Andreas Dax, Satish Dhawan, Luis M. P. Fernandes, Adolf Giesen, Thomas Graf, Theodor W. Hänsch, Paul Indelicato, Lucile Julien, Cheng-Yang Kao, Paul Knowles, Eric-Olivier Le Bigot, Yi-Wei Liu, José A. M. Lopes, Livia Ludhova, Cristina M. B. Monteiro, Françoise Mulhauser, Tobias Nebel, Paul Rabinowitz, et al. (8 July 2010). "The size of the proton". Nature **466** (7303): 213–216. Bibcode 2010Natur.466..213P. doi:10.1038/nature09250. PMID 20613837. http://www.nature.com/nature/journal/v466/n7303/abs/nature09250.html. Retrieved 2010-07-09.