PIERS 2015 Prague

Progress In Electromagnetics Research Symposium

This Draft Proceedings only contain full-length papers, which are registered and paid before May 30, 2015.

Final Proceedings will be available online by August 15, 2015.

Draft Proceedings

July 6 - 9, 2015
CZECH REPUBLIC

www.emacademy.org
www.piers.org

Calculations Concerning the Variable Size of Protons and Other Nuclei

Konstantin Meyl
Faculty of Computer and Electrical Engineering
First Transfer Center of Scalar Wave Technology (1.TZS)
Furtwangen University, Germany

Abstract— 30 years ago already, the then nuclear research center in Karlsruhe publicized experimentally determined dimensions and shapes of various nuclei. Apart from the obvious spherical shape, cylindrical and elliptical nuclei had also been found. Such experimental results have to be compared with calculations. Not only the number of p^+ and n° involved, but also spin, direction of rotation, and nuclear cohesion through magnetic moment need to fit together. The mathematical basis can already be found in the work from 1755 by the founder of the modern field theory, Prof. Roger Joseph Boscovich. According to his assumption is calculated, as an example, that the radius of a particle is dependent on the field and, ultimately, on the mass of all particles involved in the measurement. Thus the radius of the proton is reduced by muons about 5% in contrast to electrons. The factor, widely confirmed by recent measurements, is calculated. This should also apply to other atoms measured by the help of muons, when for this purpose the corresponding particle mass is influencing the calculation. At the end of the paper mathematically justified predictions are given.

1. INTRODUCTION, APPROACH

In his book "on space and time as they are recognized by us" [1] the field physicist Boscovich (1711–1787), born in Dalmatia, speaks of a "breathing of the earth", caused by the earth's rotation in the solar field, based on the law of the reverse square of the distance. This was already known 250 years ago. Therefrom follows the proportionality of an initially unknown, alternatively labeled field size Ψ, measured at a distance R from the source:

$$\Psi \sim 1/R^2. \tag{1}$$

It should be recommended that, in all cases, laws may not lose their validity when read backwards:

$$R \sim 1/\sqrt{\Psi}. \tag{1*}$$

In this notation, the length R is determined by the field Ψ and that leads inevitably to the thoughts of Boscovich. If we are closer to the sun during daytime, all linear dimensions will shrink slightly. "On the other hand, we are not able to observe this, since our body is made of the same material and it follows all changes". No physicist will succeed to contradict the statements of Boscovich. After all, we observe our surroundings with the speed of light and scan a field-dependent measure of length with the same variable, in the dimension meter or meter per second.

Consequently, the tangential velocity of the earth on the sun-facing side is smaller than on the dark side, which is why earth's orbit bends towards the sun. Helpful descriptions like gravity or centrifugal force do not even appear in this interpretation of gravitation, which is founded by Boscovich. The performance of the field theory over quantum physics becomes clear when quantum postulates, elementary particles, and the periodic table of elements are calculated mathematically [2]. A verification of the usefulness of the "new", but actually 250 year old theory is possible by the calculation of the proton radius taking into account its field dependence as an example.

2. EVIDENCE, FIELD-DEPENDENT MEASURE OF LENGTH

There are no particles without fields. Two particles, one involved by the other, add up their fields

$$(\Psi_p + \Psi_\mu) = \Psi_{\text{ges}} \sim 1/R^2.$$

They do not only reduce the distance between each other, but at the same time also their field-dependent radii. Present detection methods have the ability to measure this slight change and, thus, can point out the deficiencies of a theoretical model.

Because the mass of a particle, according to the field theory, has only the importance of an auxiliary variable, as a descriptive quantity of the actual field, it is possible to substitute the size of the field of a particle with its mass [2].

$$\Psi_{\text{ges}} \sim m_{\text{ges}} \sim 1/R^2 \tag{2}$$

If proton plus muon are involved in the measurement, the proportionality applies:

$$(m_p + m_\mu) \sim 1/R_p^2\{\mu^-\} \tag{3}$$

with the proton radius R_p\{involved particle\}. However, if an electron is involved, the proportionality is valid:

$$(m_p + m_e) \sim 1/R_p^2\{e^-\}. \tag{4}$$

The measurements differ by the relation of:

$$R_p\{\mu^-\}/R_p\{e^-\} = \sqrt{(m_p + m_e)/(m_p + m_\mu)} = \sqrt{(1836,2+1)/(1836,2+206,8)} = 0.9483. \tag{5}$$

According to the detection method, the calculated change of the proton radius is 5.17%.

The measurement using heavy muons provides more accurate results for $R_p\{\mu^-\}$. The measured result, published in Nature by Pohl et al. [3], showed:

$$R_p\{\mu^-\} = 0.84184(\pm 0.00067)\,\text{fm} \tag{6}$$

In 2013 the same team of authors measured an even more accurate value [4]:

$$R_p\{\mu^-\} = 0.84087(\pm 0.00039)\,\text{fm} \tag{7}$$

The sought-for relation should be compared with the radius of the proton, using electrons as measurement partners, such as published by Sick [5] (2011 and 2012):

$$R_p\{e^-\}_{\text{Sick}} = 0.886(\pm 0.008)\,\text{fm} \tag{8}$$

$$R_p\{\mu^-\}/R_p\{e^-\} = 0.84087\,\text{fm}/0.886\,\text{fm} = 0.949 \tag{9}$$

Especially the latest measured result from 2013 provides a shrinking of the proton of about 5.1%. This has to be compared with the calculated difference of 5.17% (Equation (5)). Practical and theoretical value are nearly identical.

3. CONCLUSION, MATHEMATICALLY JUSTIFIED PREDICTIONS

Other and older published values, as well as the CODATA value are more or less in the tolerance range:

$$R_p\{e^-\}_{\text{CODATA}} = 0.8775(\pm 0.0051)\,\text{fm}. \tag{10}$$

The large scatter range of the measurements, carried out since 1962, supports the hit ratio.

If no single model is known by today's quantum physics simply to explain the discrepancy in the measured values, the field-theoretical approach reveals its impressive performance with consequences concerning many parts of physics like electrodynamics and quantum physics [2].

For the planned measurements on deuterium or helium nuclei, predictions are possible on this mathematical basis. I expect, through the replacement of electrons by muons, a reduction of the core radius;

e.g., 2.69% in case of deuterium core (using mass of the deuteron: $m_D = 3670,5\ m_e$):

$$R_D\{\mu^-\}/R_D\{e^-\} = \sqrt{(m_D + m_e)/(m_D + m_\mu)} = \sqrt{(3670,5+1)/(3670,5+206,8)} = 0.9731; \tag{11}$$

or 1.82% in case of a tritium- or helium-3-core (using mass of triton: $m_{Tr} = 5496,9\ m_e$):

$$R_{Tr}\{\mu^-\}/R_{Tr}\{e^-\} = \sqrt{(5496,9+1)/(5496,9+206,8)} = 0.9818; \tag{12}$$

or 1.38% in case of a helium-4-core (using mass of alpha particles: $m_\alpha = 7294,3\ m_e$), if one muon, and 2.70% if two muons are involved:

$$R_\alpha\{\mu^-\}/R_\alpha\{e^-\} = 0.9862 \quad \text{resp.} := 0,9730. \tag{13}$$

4. PROSPECT

The planned experiments in Villigen, at the PSI by the MUSE group, 2 years from now, for the radius of deuterium (prediction: 2.7%) and helium-4 (1.4–2.7%, according to prediction) could contribute to the confirmation of the simple formula (5). But my mathematical prediction indicates a decrease of the influence if the involved particle mass increases. Therefore the measured result is threatened by loss of significance. I would desire the measurement of a lightweight particle, such as the antimyon μ^+. In this case, a difference of about 30% should occur.

For the same reason, the classical electron radius is so much larger than any measured.

REFERENCES

1. Boscovich, R. J., *De Spatio et Tempore ut a Nobiscognoscuntur*, 1755, translated from Latin by: Rössler, O. E., *Endophysics*, (World Scientific, 1998, cited by Meyl, K., *Self-consistent Electrodynamics*, INDEL publisher, 2010.
2. Meyl, K., *Potential Vortex*, Vol. 1–4, INDEL publisher 2014, www.meyl.eu.
3. Pohl, R., et al., "The size of the proton," *Nature*, Vol. 466, No. 7303, 213–216, 2010, doi:10.1038/nature09250.
4. Pohl, R., et al., "Muonic hydrogen and the proton radius puzzle," *Annual Review of Nuclear and Particle Science*, Vol. 63, 175–204, 2013, arXiv:1301.0905v2, doi:10.1146/annurev-nucl-102212-170627.
5. Sick, I., "Problems with proton radii," *Progress in Particle and Nuclear Physics*, Vol. 67, No. 2, 473–478, 2012.