Journal of Theoretics *Vol.4-5*

Piccard-Kessler's Experiment vs. Lorentz Contraction

V.N.Strel'tsov strlve@sunhe.jinr.ru
Joint Institute for Nuclear Research
Laboratory of High Energies
Dubna, Moscow Region 141980, RUSSIA

Abstract: According to the generally accepted opinion, the electric field of a moving charge has the form of oblate revolution ellipsoid in accordance with the Lorentz contraction formula. This picture, however, contradicts the known experiment based on the gas-efflux method.
Keywords: Lorentz contraction, Heaviside potential, Piccard-Kessler's experiment.

Heaviside's Potential

In order to illustrate Heaviside's potential, we can utilize the Coulomb potential for a charge at rest

$$\Phi^* = e/R^* \tag{1}$$

(S*-frame). For transition to the reference frame (S), where the charge is moving with velocity $v_x = \beta c$, we avail ourselves of the Lorentz transformation. In so doing, for an electric potential we have:

$$\Phi = \Phi^* (1 - \beta^2)^{-1/2} = e\gamma/R^* \quad . \tag{2}$$

On the basis of the inverse Fitzgerald-Lorentz equation $R_l^* = R_l\gamma$ and $R_t^* = R_t$, we obtain:

$$R^* = (R_t^2 + \gamma^2 R_l^2)^{1/2} = R\gamma(1 - \beta^2\sin^2\theta)^{1/2} \tag{3}$$

where θ is the angle between the direction of observation and motion, hence

$$\Phi = (e/R)(1 - \beta^2\sin^2\theta)^{-1/2} \tag{4}$$

As is seen from equation (4), the equipotential of the curves of the electric field of a moving charge takes the form of oblate ellipses. Emphasizing that the potential of a moving charge is equal to the Coulomb one only at $\theta = 0$ (Φ_{min}). One can purely conditionally treat the relativistic growth of the potential as being the consequence of the charge increasing like the growth of its mass.

The Electric Field of an Atom

Let us now consider the electron which rotates (in the xy-plane), say, around the proton in what is evidently the Bohr model of the simplest atom (hydrogen). Let us assume that the rotation radius is infinitesimal in comparison with R and introduce the polar angle $\phi = \theta + \pi/2$, rewriting equation (4) in the form:

$$\Phi^{-}(xy) = (e/R)(1 - \beta^2\cos^2\phi)^{-1/2} \quad . \tag{5}$$

Taking into account the infinitesimal nature of β ($\beta \approx 10^{-2}$) for the sum of $\Phi^{-}(xy)$ and the Coulomb potential of the proton, we obtain:

$$\Phi(xy) = e\beta^2\cos^2\phi/2R \quad . \tag{6}$$

Emphasizing again that the electric potential of the hydrogen atom turns into zero only at $\phi = \pi/2$. For the mean (per rotation period $T \approx 10^{-16}$ s) value, we find [1]:

$$< \Phi(xy) > = e\beta^2/4R \tag{7}$$

The numerical coefficient increases from 0.25 to 0.5 when one transits from the plane of the electron's orbit to its axis, and then the mean value of the potential is

$$<\Phi_H> = 3e\beta^2/8R \tag{8}$$

Thus, the electric field of the neutral atom turns out to be different from zero.

Certainly, it is impossible to distinguish the field described by eq.(8) from the Coulomb field created by the charge εe, where $\varepsilon = 3\beta^2/8$. Therefore, the quantity εe can be fully interpreted (in accordance with the forenamed remark) as a certain effective charge. What is more, just the atom is considered as the object (see, e.g., [2,3]) which allows one to verify the influence of motion on the charge.

Piccard-Kessler's Experiment

The discussed effect would seem to have to manifest itself in the known experiments based on the gas-efflux method [4-6]. The first of them was performed by Piccard and Kessler in 1925. In these experiments, a great volume of gas was subjected to compression in a container that was completely electrically isolated from its surroundings. Then, the gas was released from the container so that the usual ions might not go out with it. If the atoms had an electric field, the withdrawal of all the mass of the gas would substantially change the container's potential. It follows from these experiments, that the value of ε must not exceed 10^{-21}, and in accordance with (8) $\varepsilon \approx 10^{-4}$. One try to save the contraction formula at the cost of the refusal from Bohr's atom theory, forgetting about its dazzling agreement of its theoretical values of frequency of the hydrogen spectrum, with the experimentally observed ones.

Conclusion

Thus, the considered experiments testify against the generally accepted representation of the moving charge field in the spheroid form. In its turn, it is a direct consequence of the deep-rooted idea of the contraction of longitudinal sizes in motion.

References

1. Strel'tsov V.N. - The Electric Field of Bohr's Atom. JINR D2-94-212, Dubna, 1994.
2. Purcell E.M. - **Electricity and Magnetism**. McGrow-Hill, N.Y., 1965, sec.5.4.
3. Jackson J.D. - **Classical Electrodynamics**. 2nd Ed., Wiley, N.Y., 1975, p.547.
4. Piccard A., Kessler E. - Arch.Sci.Phys.Nat.., 1925, **7,** p.340.
5. King J.G. - Phys.Rev.Lett., 1960, **5**, p.562.
6. Dylla H.F., King J.G. - Phys.Rev., 1973, **7A**, p.1224.

Journal Home Page