Mo-4-(Invited)

On the precise value of the electrodynamic fine structure constant α

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The em fine structure constant α is a very important dimensionless fundamental constant and enters in the descriptions of nearly all physical processes in electromagnetism e.g. the interaction of radiation with matter in general. Thus, in the last 75 years, there have been proposed a huge number of simple formulae which claimed to precisely determine the numerical value of α. All such attempts failed because they had no physical base, and mainly were a playing-around with natural numbers and simple algebraic functions. And these results only could be compared with the experimental values of the past, which were far from being highly-accurate.

Now we propose a new equation for the reciprocal em fine structure constant α -1 at low energies. We will show that our formula has a solid physical background. We only refer to considerations about the so-called running coupling constant discussed in special GUT theories, and on a simple first-order QED correction, which quantitatively can be deduced from usual QED calculations on the 'vacuum polarization'.

From our proposed equation, derived, but not published, in January 2006 and therefore in advance to the publications [1] cited below, we calculate α^{-1} to:

$$\alpha^{-1} = 16\pi e\left(1 + 1.261111111...\left(\alpha/\pi\right)\right) = 137.0359992264... .$$

This is in excellent agreement with the newest (2007) and best experimental value obtained by g-factor measurements of the free electron, and measurements of the Rydberg constant of Rb and Cs atoms [1]. Namely, averaging and weighing these recent experimental results, and considering a very small 5th order QED correction in the value derived from the g-factor measurements (see the discussion in the Erratum [1]) we have to compare our value with:

$$\left(\alpha^{-1}\right)_{\exp(2007)} = 137.03599921\left(15\right).$$

If one would neglect the error bar for this experimental value, one may conclude that our value for α^{-1} would have a precision of 10^{-10} (!).

References

[1] Gabrielse, G. et al., Phys. Rev. Lett. (PRL), 97, 030802 (2006); and their Erratum in PRL, 24. June 2007.