Uwe J. M. Reichelt

The physical meaning of the fine structure constants

abstract

The fine structure constant is one of the guidelines natural constants in physics. Their physical meaning gilded as a riddle. This is to be clarified in this work and its real meaning in physics will be developed and seen. The new result shows that the periodic table of the chemical elements has an upper limit.

introduction

The fact that it can be measured very precisely on its own, like all other constants that describe it, gave it its mythical reputation and so far there is no plausible explanation for its existence. Since its discovery by Arnold Sommerfeld in 1916, the fine structure constant has gained increasing importance in physics. At the same time, interest grew in what its actual physical meaning is, because it is only an irrational number, which can, however, be expressed by a formula that consists of other natural constants such as elementary charge, reduced Planck's constant, the speed of light, permittivity and Ludolf's number π.
This work shows that their importance could have been recognized as early as 1906, when Max Planck traced all physically significant quantities back to 5 natural constants: the gravitational constant, the speed of light, the reduced Planck constant, the Boltzmann constant and the electrical permittivity of the vacuum.
Here, the mystery of the fine structure constant becomes a simple, physically clear to be interpreted ratio, so its character is exactly something like the circle number π.

What is the fine structure constant?

Lemma 1: The gravitational force between two Planck masses (F_{GP}) is exactly as great as the electrostatic force between two Planck charges (F_{QP}).

Proof:
Planck mass $m_P = (\mathbf{hc} / 2\pi\mathbf{G})^{1/2}$ and Planck charge $Q_P = (4\pi\boldsymbol{\varepsilon_0}\mathbf{hc}/2\pi)^{1/2}$
$F_{GP} = G\, m_P^2 / r^2$ $\qquad F_{QP} = Q_P^2 / 4\pi\, \boldsymbol{\varepsilon_0}\, r^2$
$F_{GP} = F_{QP} = \mathbf{hc} / 2\pi\, r^2$ q.e.d.

Lemma 2: If you multiply the electrostatic force between two Planck charges (F_{QP}) by the fine structure constant (α) this gives the Coulomb force between two elementary charges (F_C).

Proof:
$\alpha = 2\pi\, \mathbf{e}^2 / 4\pi\, \boldsymbol{\varepsilon_0}\, \mathbf{h\, c}$ $\qquad F_C = e^2 / 4\pi\, \boldsymbol{\varepsilon_0}\, r^2$
$F_C = \alpha\, F_{QP} = (2\pi\, \mathbf{e}^2 / 4\pi\, \boldsymbol{\varepsilon_0}\, \mathbf{hc})(\mathbf{hc} / 2\pi\, r^2) = e^2 / 4\pi\, \boldsymbol{\varepsilon_0}\, r^2$ q.e.d.

From these two theorems it follows that the fine structure constant is the ratio between the Coulomb force between two elementary charges and the electrostatic force between two

Planck charges or as the ratio between the squares of the electrical elementary charge and the Planck charge.
However, the real meaning only emerges when it is clarified what the expression is

$$F_{GP} = F_{QP} = \mathbf{h}\,\mathbf{c} / 2\pi r^2$$

means. It seems to be a force stronger than the Coulomb force by the reciprocal value of the fine structure constant with the same distance behavior. One can approach their understanding through the path described below.
A force is sought that can keep a quantum fast of light stable on a circular path. The quantum opposes this force with an equally large centrifugal force through the inertia inherent in its energy. This centrifugal force (F_Z) can be described as

$$F_Z = (\mathbf{h}\,\nu / c^2)\,(\mathbf{c}^2 / r) \quad \text{and with } \nu = \mathbf{c}/\lambda \text{ results in that } F_Z = \mathbf{h}\,\mathbf{c} / \lambda\, r$$

Since a light-fast quantum is a wave and the orbit should be stationary, the circumference of the path must correspond to a wavelength. An integer shortening of the wavelength, which would also correspond to a stationary orbit, would lead to a multiplication of the circulating energy and is of no importance here. So the wavelength of this quantum would be $\lambda = 2\pi r$.
Inserted for the centrifugal force of such a quantum rotating at the speed of light, the relationship arises

$$F_Z = \mathbf{h}\,\mathbf{c} / 2\pi r^2$$

That is exactly the same as the amount mentioned above. The value "F_Z" thus represents a force limit through the finite speed c.
From these considerations, the physical meaning of the fine structure constants results as the ratio of the Coulomb force of two elementary charges to an elementary maximum possible force limit limited by the speed of light.

Consequence from the existence of the fine structure constant

In addition to the influences of the fine structure constants that have been active in physics up to now, there is a not yet recognized, essential effect that influences the periodic table of the chemical elements: the periodic table is limited upwards by the fine structure constant.
In the case of the 137 chemical element, the speed of rotation of the inner electrons should be approx. 99.97% of the speed of light and their mass should increase by almost 41 times, because 137 positive charges exert almost the same force as described above on a negative elementary charge. Such a state, if it could exist at all, would be extremely unstable. Element 138 cannot theoretically exist.
One can claim that the periodic table of the chemical elements consists of a maximum of 136 elements and that the elements will become increasingly unstable by then.