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MORE WAYS TO CALCULATE THE ELECTRON MASS

It is known (see "http://en.wikipedia.org/wiki/Electron_rest_mass") that the electron mass in kilograms m_e is calculated based on the accepted by the modern science determination of the Rydberg constant $R_\infty = \frac{m_e c\alpha^2}{2h}$, from which

$$m_e = \frac{2hR_\infty}{c\alpha^2} \qquad (1).$$

Here c is the speed of light in vacuum, α – the fine structure constant, and h - is the Planck constant.

The electron mass calculated by the formula amounts to $9.109\ 382\,15(45) \cdot 10^{-31}$ kg, and the relative uncertainty 5×10^{-8} in the recommended value is due entirely to the uncertainty in the value of the Planck constant.

The reason of this electron mass calculation method becomes clear if one takes in consideration that according to my previous article “QUANTUM MECHANICS’ FOUNDATION, HOW STRONG IS IT?” http://wbabin.net/physics/dunaev1.pdf, the fine structure constant can be calculated by the formula $\alpha = 2\pi R_\infty R_{H_2}$, where R_{H_2} is the hydrogen molecule electron orbit radius, and the Planck constant by the formula $h = 2\pi^2 m_e c R_\infty R_{H_2}^2$. Having put the obtained values to $\frac{2hR_\infty}{c\alpha^2}$, after all the reducing one obtains $\frac{2hR_\infty}{c\alpha^2} = m_e$.

According to the Coulomb law the force attracting the orbital electron to the hydrogen molecule nucleus is

$$F_{H_2} = k_e \frac{2q^2}{R_{H_2}^2} \qquad (2),\ \text{where}$$

R_{H_2} is the electron orbit radius, k_e is the proportionality coefficient of the Coulomb law equaling $8.9875517873681764\cdot10^9$ Nm^2C^{-2}, and q is the unitary electric charge which is $1.602\ 176\ 487(40)\cdot10^{-19}$ C.

According to the already cited article the same force has to equal

$$F_{H_2} = K_{H_2} \frac{s_e}{R_{H_2}^2} \qquad (3),$$

where s_e is the electron screening area that is equal to its cross section area, and K_{H_2} is the Kepler constant for the hydrogen molecule.

As it was found in the same work the hydrogen molecule electron orbit radius amounts to $R_{H_2} = 1.058354\cdot10^{-10}$ m. Besides it is known that the electron orbiting frequency in the hydrogen molecule makes cR_∞=3.289842·10^15 c^-1, which makes it possible to find out the Kepler constant for the hydrogen molecule planetary system as $K_{H_2} = {R_{H_2}}^3 (2\pi c R_\infty)^2 = 506.527$ m^3c^-2.

From the equations (2) and (3) one can obtain

$$K_{H_2} s_e = k_e 2q^2 \qquad (4),$$

that allows to determine

$$s_e = \frac{2k_e q^2}{K_{H_2}} = \frac{2 \cdot 8.987552 \cdot 10^9 \cdot (1.602176 \cdot 10^{-19})^2}{506.527} = 9.109389 \cdot 10^{-31} \text{ kg},$$

The found result actually coincides with the standard value of the electron mass in kg, which confirms the previously http://wbabin.net/physics/dunaev.pdf expressed affirmation that the electron mass, as well as those of other subatomic particles are their screening areas, which for the electron is equal to its cross section area. The fact that in this case such area is calculated not in m² but in kg is only the result that in this case the calculation was not made in the ethereal but in the traditional unities system.

With the above in mind

$$m_e = s_e = \frac{2k_e q^2}{K_{H_2}} = 9.109389 \cdot 10^{-31} \text{kg} \qquad (5).$$

If the hydrogen molecule nucleus creates the screening effect equaling the double screening effect of a proton (see www.wbabin.net/eeuro/dunaev10.pdf), which requires to put two to the numerator of the formula (5), then with regard to other atoms and molecules the same formula (5) may be generalized as follows

$$m_e = \frac{\eta k_e q^2}{K} \qquad (6), \text{ where}$$

η is the relation between the screening effect (screening area) of the respective atom or molecule nucleus and the screening effect or cross section area of the proton, and $K = \eta K_p$ is their Kepler constant, where K_p is the Kepler constant for a system with only one proton (hydrogen atom).

The Kepler constant for the hydrogen molecule can be determined through principal constants, e.g. the speed of light, fine structure constant and Rydberg constant if only one takes in consideration that according to the above mentioned article "QUANTUM MECHANICS' FOUNDATION, HOW STRONG IS IT?" http://wbabin.net/physics/dunaev1.pdf $\alpha = \frac{\omega R_{H2}}{c}$, where ω is the electron angular velocity that equals $\omega = 2\pi R_\infty c$. Then $R_{H_2} = \frac{\alpha c}{\omega} = \frac{\alpha}{2\pi R_\infty}$, and the Kepler constant will make

$$K_{H_2} = \left(\frac{\alpha}{2\pi R_\infty}\right)^3 (2\pi R_\infty c)^2 = \frac{c^2 \alpha^3}{2\pi R_\infty},$$

which allows transforming the formula (5) to:

$$m_e = \frac{4\pi R_\infty k_e q^2}{\alpha^3 c^2} \qquad (7).$$

The electron mass calculated by the formula makes

$$m_e = \frac{4\pi\alpha^3 R_\infty k_e q^2}{c^2} = \frac{4\pi \cdot 10\,973\,731 \cdot 8.9875518 \cdot 10^9 (1.602\,176\,487 \cdot 10^{-19})^2}{(7.297\,352\,5376 \cdot 10^{-3})^3 \cdot (299\,792\,458)^2} = 9.10938169 \cdot 10^{-31} \text{ kg},$$

that is decisively close to the standard value.

Conclusions:

1) The electron mass in kg can be calculated by the formula $m_e = \frac{\eta k_e q^2}{K}$, where η is the relation between the screening effect of a respective atom or molecule nucleus to the screening effect alias the cross section area of the proton, k_e- is the proportionality coefficient in the Coulomb law, q is a unitary electric charge, and K – is the Kepler constant for the chosen atom or molecule;
2) While using for the electron mass calculation data relating the hydrogen molecule, one may represent the calculation formula as $m_e = \frac{2k_e q^2}{K_{H2}}$, where K_{H_2} is the Kepler constant for this molecule, or also as $m_e = \frac{4\pi\alpha^3 R_\infty k_e q^2}{c^2}$, where α is the fine structure constant, R_∞ is the Rydberg constant and c is the speed of light in vacuum;
3) The proposed method of the electron mass calculation ones more affirms the equivalency of its mass to its cross section area that stands for its screening effect.