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# Planck Permittivity and Electron Force

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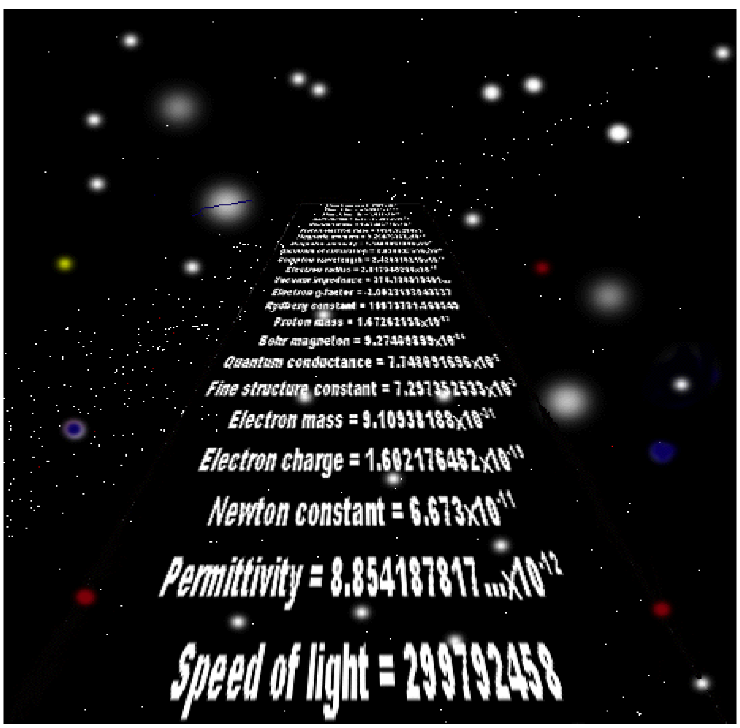
The Planck permittivity is derived from the Planck time and becomes an important parameter for the definition of a black hole model applied to Planck quantities. The emerging particle has all the characteristics of a black hole electron and a precise evaluation of its gravitational and electric force is now possible.

## *Introduction*

Our universe is filled with constants, they regulate our life and we make a continuing effort to improve their accuracy. For most of them we found a reasonable explanation while for others we are still making intelligent guesses. Why we have such specific electron mass and charge? What is the relation of the constant of gravity with other quantum constants? And so forth.




The Planck particle could be the answer to our questions.

If we devise a hypothetical particle with a Planck time $t_p = (\pi hG/c^5)^{1/2}$ and a Planck mass $M = h/t_p c^2$ we have created the basis for a black hole, a Planck black hole, as mentioned in a previous paper [1] on which this present work on the Planck permittivity is based.

The Planck entity was indeed considered in the past as a possible candidate for a particle but its huge difference with any known particle was a major obstacle. In actual fact, what we would experience from our frame of reference outside this hypothetical black hole is not mass $M$ but a much smaller mass $M_0 = M t_p^{1/2}$. We would not be aware of the sec$^{1/2}$ dimension present in $M_0$ but it will be always present in any calculation and will have a ripple effect on other quantities. What we are implying is that any force or energy outside the black hole is

dependent on the Planck time. The resulting numbers are the ones we would expect from the MKSA system. Paradoxically, if we would introduce the electric dimensions as defined in the MKSA system we would exclude the possibility to find a link between electricity and gravity as the MKSA system was not conceived with a unified theory in mind. In this respect the cgs system would have been a better alternative, nevertheless we will abide by the MKSA system which will give us numbers we all know but we must be prepared to see quantities with different dimensions when dealing with electric parameters; even so, all equalities are dimensionally balanced as expected, although they may not appear so at a cursory glance.
The most suitable model to represent the Planck black hole is the ring model [2,3], a toroidal force field rotating around a tiny kernel representing our black hole. This model will eventually develop in the electron but first we have to define the Planck charge $Q$ with an energy equivalent to the Planck mass $M$:

$$Q \;=\; M\,(4\,\pi\,\varepsilon_p\,G)^{1/2} \;=\; (4\,\varepsilon_p\,h\,c)^{1/2} \qquad (1)$$

In order to find $Q$ we have to find the Planck permittivity $\varepsilon_p$ and its definition will give us a better insight in the intimate structure of the Planck particle.

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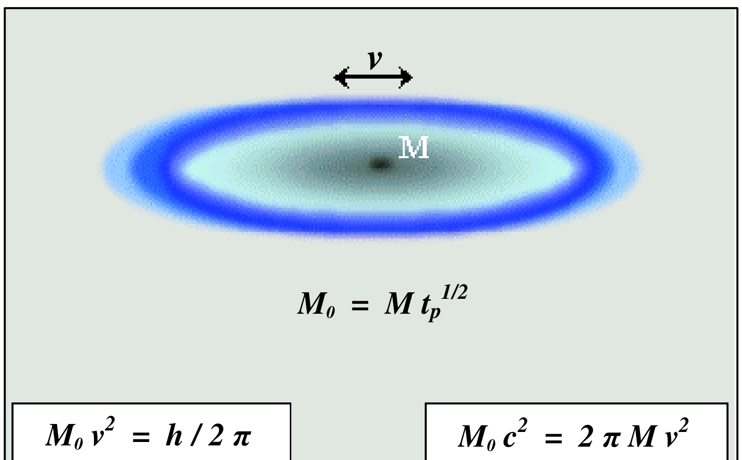
## *Planck permittivity*




The Planck black hole would have a mass $M$ and would move about with speed $v$ resulting from the minimum quantum of action applied to $M_0$. Outside the black hole we would experience mass $M_0$ only and its energy would be the same as the kinetic energy of mass $M$.

In our black hole model we might think that mass $M_0$ would not stand still but would move at a velocity $v$ with the minimum quantum of action represented by $h$:

$$M_0\,v^2 \;=\; h\,/\,2\,\pi \qquad (2)$$

The dimension for $v$ will become clear later in this section. As $M$ and $M_0$ are really the same particle, we could think that $v$ applied to mass $M$ is its kinetic energy, which would be equal to the energy of mass $M_0$:

$$M_0\,c^2 \;=\; 2\,\pi\,M\,v^2 \qquad (3)$$

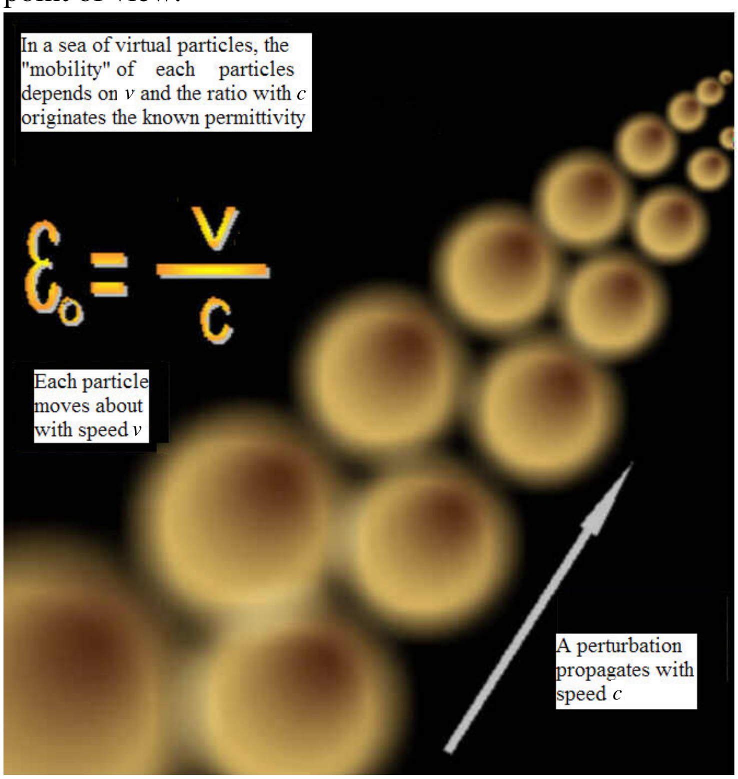
If we square both terms and multiply by the constant of gravitation we have:

$$G\,M_0^2\,/\,G\,M^2 \;=\; 4\,\pi^2\,(v\,/\,c)^4 \;=\; t_p \qquad (4)$$

We define the Planck permittivity $\varepsilon_p$ as the ratio *v/c* and if we substitute the gravitational force of mass *M* with the equivalent force given by the Planck charge *Q* we have:

$$G\, M_0^{\,2} \,/\, (Q^2 \,/\, 4\,\pi\,\varepsilon_p) \;=\; 4\,\pi^2\,\varepsilon_p^{\,4} \;=\; t_p \qquad (5)$$

From the above equation we get $\varepsilon_p$ directly from the Planck time and once we find charge *Q* we could also write $\varepsilon_p = Q^2/4hc$. The ratio of the gravitational to the electric force in a Planck black hole is exactly $t_p$. The same ratio applied to an electron will give us a number very close to $t_p$, only 0.2% off, due to the fact that rotation has not been taken care of, as yet. Here we see clearly the problem we have with the Planck particle: we expected a dimensionless ratio but in fact we find a time dimension. This time dimension must be always accounted for when we write any equation but we will not have any experience of it. This means, for example, that the actual dimension of speed *v* is (m/sec) $\sec^{1/4}$ but numerically it is the inverse of vacuum resistivity, an admittance. Planck permittivity is equal to $(t_p/4\pi^2)^{1/4}$ but also in this case we would not experience the $\sec^{1/4}$ dimension and it would appear to us as a dimensionless number. It is not by chance that if we ignore the $\sec^{1/4}$ dimension we have exactly the same dimensions as in the cgs system where the dimension of charge is not present but only the three fundamental dimensions of space, time and mass. Now we see that eq. 2 and 3 are indeed correct also from the dimensional point of view.




Permittivity is a fundamental property of vacuum and to define it as the *v/c* ratio throws some light on what could be the property of the virtual particles present in it. *v* is numerically the vacuum conductance but proper experiments might even be able to identify a physical speed *v*.

It is time now to take in account the rotation of the particle. A speeding point on the spinning ring would be the result of two equal relativistic velocities *u* such that a point on the torus, or ring, would follow a helical path with a resulting speed $u_0$. We would then relate the initial fine structure constant $\alpha_0$ to $u_0$ as follows:

$$\alpha_0 \;=\; 2\,(1 - u_0^{\,2} \,/\, c^2) \qquad (6)$$

In order to find $u_0$ we must first find $\alpha_0$. It was felt that $\alpha_0$ would be mirrored on some physical property of our black hole and we would see it as an indication of the energy of the Planck charge within time $t_p$ compared to the energy of the unitary charge $Q_u$ within the unitary time $t_u$. In this respect we create a charged ring with unitary charge $Q_u$ and form factor $4\pi^2$, in order to have a reference against which we can measure the strength of charge $Q$. Its ratio would give us the initial fine structure constant $\alpha_0$:

$$\alpha_0^2 = (16\,\pi^4\,Q_u^2\,/\,t_u)\,/\,(Q^2\,/\,t_p) \qquad (7)$$

This constant could be seen as a sort of scaling factor, i.e. how much weaker is the ratio $Q^2/t_p$ compared to a constant $W_u = 16\pi^4 Q_u^2/t_u$ which numerically is just $16\pi^4$ but we must always bear in mind the dimensions it carries with it and that we will find in many important equations concerning the electron.
We could write the initial fine structure constant $\alpha_0$ in terms of fundamental constants only, as shown in the table at the end. The resulting speed $u_0 = c(1-\alpha_0/2)^{1/2}$ will originate a set of parameters close to the ones we known, including a better value for the permittivity now equal to $(Q\,c/u_0)^2/4hc$. These data would apply to what we would call an initial electron and a perfect correspondence is achieved once we adjust the rotational speed to a slightly lower value.

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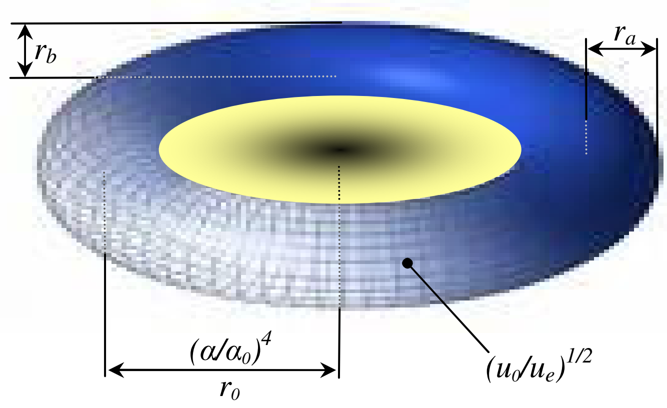
## *Electron force*

Due to interactions with virtual particles present in the vacuum, the rotational speed would decrease by a small amount, from $u_0$ to $u_e$, just enough to yield all the electron parameters as we know them. Hence there is a set of parameters corresponding to the initial speed given by $u_0$, and a set of parameters corresponding to the final speed given by $u_e$. One important quantity is the fine structure constant and its variation from its initial value $\alpha_0$ to its known value $\alpha$ is given by a solution of a cubic equation, see table at the end, where it is written in terms of fundamental constants, which include also the unitary charge and time $W_u$.




After slowdown the torus radius $r_0$ increases by the amount $(\alpha/\alpha_0)^4$. The same would apply to radius $r_a$ and $r_b$ of the torus ellipse. The speed decrease from $u_0$ to $u_e$, hence the ratio $((2-\alpha_0)/(2-\alpha))^{1/4}$, is also taken care of.

The electron mass can be calculated in terms of the apparent Planck mass $M_0$ and its radius variation proportional to the fourth power of the fine structure variation. The ring radius and the ring section radii would undergo the same change, in addition, the speed variation given by $(u_0/u_e)^{1/2} =((2-\alpha_0)/(2-\alpha))^{1/4}$ is to be accounted for  and eventually we would have:

$$m_e \;=\; M_0\,(\alpha/2)^{1/2}\,(\alpha/\alpha_0)^{12}\,(1-\alpha/2)^{3/8}\,((2-\alpha)/(2-\alpha_0))^{1/4} \qquad (8)$$

$(1\text{-}\alpha/2)^{3/8}$ is the intrinsic mass decrease due to rotation. Before slowdown it is $(1\text{-}\alpha_0/2)^{1/8}$ for each radius and becomes $(1\text{-}\alpha/2)^{1/8}$ after slowdown. Other very small factors, if any, affecting $m_e$ can be disregarded. For the electron charge $e$ we have an equation which we are able to write in terms of the Planck charge $Q$:

$$e \;=\; Q\,(\alpha/2)^{1/2}/(\alpha/\alpha_0)\,(1-\alpha/2)^{1/2} \qquad (9)$$

Since Q is actually derived from fundamental constants, we could write, after elaboration of eq. 9, a new and interesting equation for the electron charge $e$:

$$e \;=\; 4\,\pi^2\,(t_p/\alpha\,(2-\alpha))^{1/2} \qquad (10)$$

Where $4\pi^2$ is actually $W_u^{1/2}$ we have seen before. With the quantization of the electron mass and charge written in terms of its basic Planck quantities we are in a position to draw an important hypothesis on the forces present in our particle; the force given by mass $M$ is experienced in our world as a force given by charge $Q$. At the same time we have a force $t_p$ times smaller that we identify as the gravitational force. We have also seen that time $t_p$ and permittivity $\varepsilon_p$ are directly related and as a consequence we may write a relationship linking the electric and gravitational force in an electron.

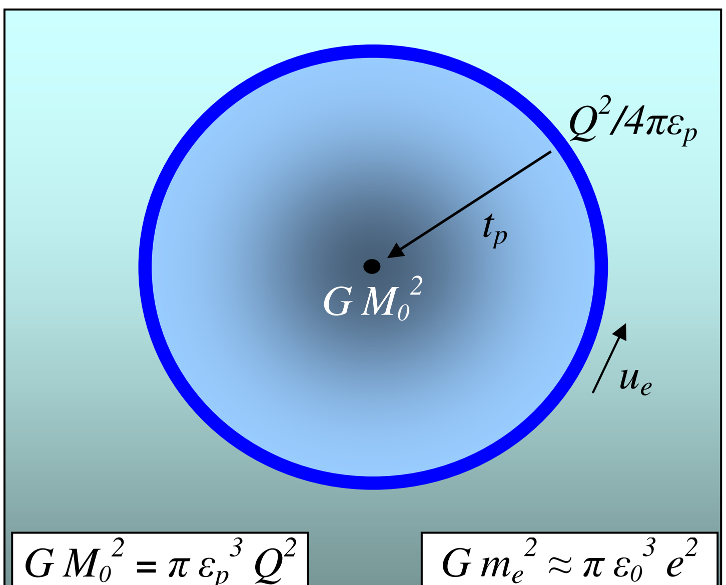
We start from eq. 5 connecting directly the gravitational and electric force. After rearranging its terms we have:

$$G\,M_0^{\,2} \;=\; \pi\,\varepsilon_p^{\,3}\,Q^2 \qquad (11)$$

The same equation can be written in terms of known constants but with an additional term $C$ representing the change of parameters due to rotation and its subsequent slowdown:

$$G\,m_e^{\,2} \;=\; \pi\,\varepsilon_0^{\,3}\,e^2\,C \qquad (12)$$

By taking in account the variation of each quantity due to the speed variation we find $C = (\alpha/\alpha_0)^{32}(1\text{-}\alpha/2)^{19/4}((2\text{-}\alpha)/(2\text{-}\alpha_0))^{1/2}$ This term is close to unity and if we are happy with a 1% difference between the left and right side of the equation we have:



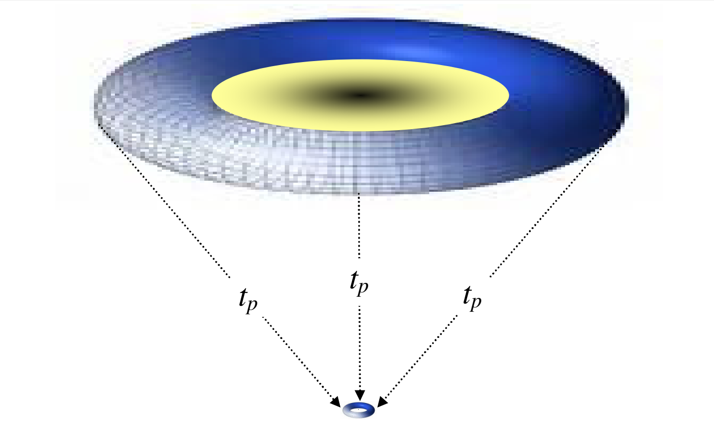

At speed $u_e$ all parameters will undergo a slight change, but the basic relationships remain valid making it possible to relate directly the electron mass and charge in a beautiful equation without the need of the ubiquitous electron radius.

$$G\, m_e^2 \;\approx\; \pi\, \varepsilon_0^3\, e^2 \qquad (13)$$

Despite its appearance, eq. 13 is dimensionally balanced as an additional time dimension is present in the left term. This equation is a good example of new relationships among electron parameters now possible through the elaboration of a black hole model. Another example is the known permittivity $\varepsilon_0$ that can be given in terms of the Planck permittivity $\varepsilon_p$ and the variation of the fine structure constant:

$$\varepsilon_0 \;=\; \varepsilon_p \,/\, (\alpha \,/\, \alpha_0)^2\, (1 - \alpha \,/\, 2) \qquad (14)$$

We can now explain why the ratio of the gravitational to the electric force in an electron is close but not quite the same as the Planck time. We have seen that a particle with charge $Q$, permittivity $\varepsilon_p$ and apparent mass $M_0$ has a gravitational to electric force ratio exactly equal to Planck time $t_p$ (eq. 5) and the same applies to a rotating particle. The interaction with virtual particles decreases the rotational speed by 111m/s and yields a different set of parameters which we identify with the electron as we know it.




The gravitational force of the Planck particle is drastically reduced by the limitation imposed by Planck time $t_p$. The gravitational force of the resulting particle, the electron, has now a time dimension which must be taken care of. A precise correspondence with the electric force is established once the rotational factor $(\alpha/\alpha_0)^{24}(1-\alpha/2)^{3/4}((2-\alpha)/(2-\alpha_0))^{1/2}$ is considered.

An electron spinning at this lower speed has a slightly different permittivity, charge and mass but these parameters are in a well defined relationship with the original Planck quantities. Eventually the ratio of the gravitational to the electric force $F_g/F_e$ in an electron will result in a modest 0.2% difference from the Planck time.

We are now in a position to account for this small difference and by calculating the variation taking place in each quantity we find the term related to the ratio $F_g/F_e$ applied to an electron:

$$F_g \,/\, F_e \;=\; t_p\, (\alpha/\alpha_0)^{24}\, (1-\alpha/2)^{3/4}\, ((2-\alpha)/(2-\alpha_0))^{1/2} \;\approx\; t_p \qquad (15)$$

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## Conclusion

The details of the Planck particle and its behavior as a black hole give us an insight in the link between the Planck particle and the electron, shedding light on its nature and on the forces surrounding it. An additional time dimension is present in many quantities

concerning the basic Planck particle. Such a particle, once its rotation is taken in account, appears to us as the electron.
Quantity $W_u$, numerically equal to $16\pi^4$, is present in many equations and must be accounted for in order to have dimensionally balanced equations.
The table below shows numerical results that are mostly within one standard deviation of the latest Codata listing. All calculations should be carried out with a high precision program, 20 digit precision at least.

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|---|---|---|
| **Initial data** | | |
| $c = 299792458$ | $h = 6.62606944283\text{x}10^{-34}$ | $G = 6.672918952267\text{x}10^{-11}$ |
| **Planck data - non rotating particle** | | |
| Planck time $t_p$ | $(\pi\, h\, G / c^5)^{1/2}$ | $2.3950197\text{x}10^{-43}$ |
| Planck mass $M$ | $h / t_p\, c^2$ | $3.0782613\text{x}10^{-8}$ |
| Apparent Planck mass $M_0$ | $M\, t_p^{1/2}$ | $1.5064684\text{x}10^{-29}$ |
| Planck permittivity $\varepsilon_p$ | $(t_p / 4\, \pi^2)^{1/4}$ | $8.825459772\text{x}10^{-12}$ |
| Planck charge $Q$ | $(4\, \varepsilon_p\, h\, c)^{1/2}$ | $2.648116\text{x}10^{-18}$ |
| **Electron data - rotating Planck particle** | | |
| Unitary energy in unitary time $W_u$ | $16\, \pi^4\, Q_u^2 / t_u$ | 1558.5454565 |
| Initial fine structure constant $\alpha_0$ | $(4\pi^5/ c^3)^{1/2}\, (2\, G / h)^{1/4}\, (c / \pi\, h\, G)^{1/16}$ | $7.2958731748\text{x}10^{-3}$ |
| Fine structure Constant $\alpha$ | solve: $\alpha^3 - 2\alpha^2 + (2\pi)^5\, (\pi\, G/c^3\, h)^{1/2}/10^7 = 0$ | $7.2973525719\text{x}10^{-3}$ |
| Permittivity $\varepsilon_0$ | $\varepsilon_p / (\alpha / \alpha_0)^2\, (1 - \alpha / 2)$ | $8.8541878176\text{x}10^{-12}$ |
| Mass $m_e$ | $M_0(\alpha/2)^{1/2}(\alpha/\alpha_0)^{12}(1-\alpha/2)^{3/8}((2-\alpha)/(2-\alpha_0))^{1/4}$ | $9.10938272\text{x}10^{-31}$ |
| Charge $e$ | $4\, \pi^2\, (t_p / \alpha\, (2 - \alpha))^{1/2}$ | $1.60217655\text{x}10^{-19}$ |
| Electric force $e^2 / 4\, \pi\, \varepsilon_0$ | $(\alpha / 2)\, Q^2 / 4\, \pi\, \varepsilon_p$ | $2.3070773\text{x}10^{-28}$ |
| Gravitational force $G\, m_e^2$ | $\pi\varepsilon_0^3\, e^2(\alpha/\alpha_0)^{32}(1-\alpha/2)^{19/4}((2-\alpha)/(2-\alpha_0))^{1/2}$ | $5.5372451\text{x}10^{-71}$ |
| Gravity to electric force ratio $F_g / F_e$ | $t_p\, (\alpha/\alpha_0)^{24}\, (1-\alpha/2)^{3/4}\, ((2-\alpha)/(2-\alpha_0))^{1/2}$ | $2.4001125\text{x}10^{-43}$ |

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## References


**1)** D. Di Mario, (2003), *Magnetic anomaly in black hole electrons*, http://digilander.iol.it/bubblegate/magneticanomaly.pdf

**2)** D. L. Bergman & J. P. Wesley, (1990), *Spinning charged ring model of electron yielding anomalous magnetic moment*, Galilean Electrodynamics, Vol. 2, 63-67.

**3)** M. Kanarev, *Planck's constant and the model of the electron,* http://www.journaloftheoretics.com/Links/Papers/Kanarev-Electron.pdf