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Reality of the Planck Mass

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The Planck mass is not the elusive particle so often depicted, but it is the constituent part of each electron and neutrino. If the Planck mass is considered as a charged black hole, we find that the electron mass and charge are a natural corollary. The faster the rotation of the Planck mass the lower its measurable mass appears to be: at the speed of light we are left with a massless and chargeless particle that is identified with the neutrino. Finally, the interaction of the Planck charge with virtual particles in the vacuum seems to yield the right charge for the d-quark and a negative fine structure constant that seems to imply a speed faster than light.

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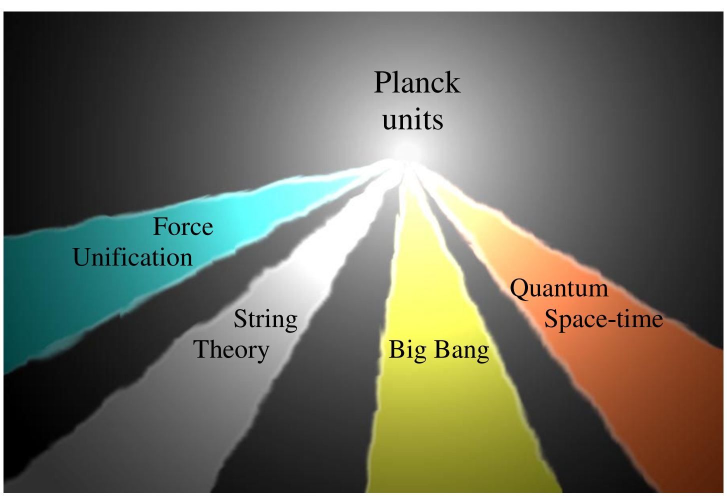
Introduction

Uniton, geon, roton are some of the names attributed to the Planck mass with the intent to better explain some of the peculiarities of the relevant theory, be it the string theory, the quantum space-time, the big bang and so on. All these theories converge towards a supposedly grand unification where most, if not all, could be explained with the basic Planck units of length, time and mass. Now we know that the Planck length and time are beyond our capacity of detection due to their small value, but the Planck mass with a weight of tens of micrograms should be quite easy to find, yet, so far no trace of it has emerged. Its energy is so high that no present or future laboratory can conceivably produce even a single particle. So elusive is this particle that someone has even thought it might not exist at all and the Planck mass is only the result of playing with numbers. On occasions it has been endowed with fanciful properties or relegated to a very short life in the early stage of the big bang.



The recognized value for the Planck mass is $(\hbar c/G)^{1/2}$ = 2.18x10^{-8} Kg but you may find also the value 5.46x10^{-8} Kg depending on whether h or $\hbar$ appears in the equation giving such a mass. In cosmology it is occasionally mentioned the value $(\hbar c/8\pi G)^{1/2}$ = 4.34x10^{-9}

Kg. In this paper we will give the Planck mass M the value $(hc/\pi G)^{1/2} = 3.08\text{x}10^{-8}$ Kg. We really do not know the precise geometry of a Planck particle and the proposed number for the Planck mass could fit an acceptable model.
The Planck time t_p is accordingly calculated as $h/Mc^2 = 2.4\text{x}10^{-43}$ sec.
As we have seen, no matter how it is calculated, the Planck mass is extremely big even compared with the most massive particles. Its weight is in the range of a large molecule and it is just impossible not to see it. In fact it is all around us albeit under false pretences.

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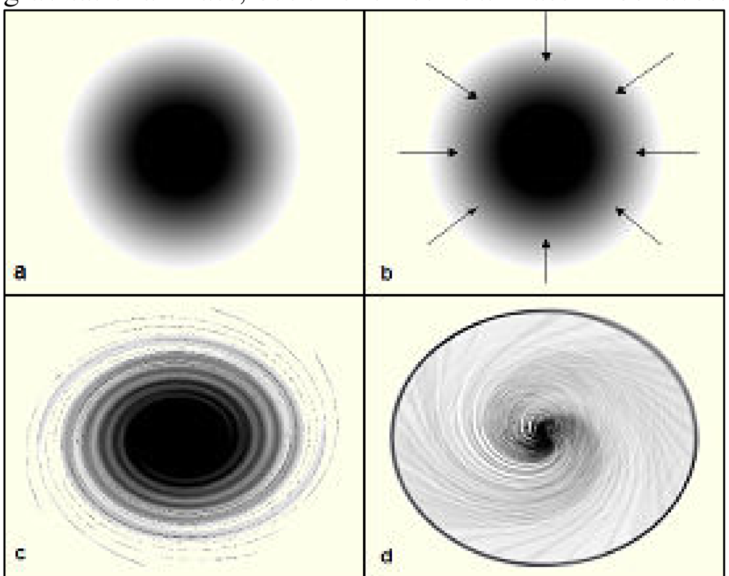
The Planck particle

The reason why we could not find the Planck mass M is because we were looking for a gravitational mass, but this is not how mass M behaves. In our hypothesis we have to see M as a black hole. We would then think that such a particle would either shrink into nothing or increase its size. To our senses neither of the two actually would take place; this would be forbidden by the ever increasing time dilation factor taking place near the black hole. What we would experience is the "tendency"; in other words, we would be left with a sign only: positive or negative depending on whether the particle would tend to shrink or enlarge, either diverging or converging arrows as in fig. b. The variation of mass would look like "frozen" in its initial state but we would experience a sign, positive or negative, and it is to this peculiarity that we assign the name charge. At this point we would no longer require the introduction of the dimension of charge as we could write everything with the dimensions of length, time and mass only. Yet, the dimension of charge is still retained for practical purposes provided that a comparison is made with the unitary charge.



The Planck mass is seen as a black hole (a), with a specific charge (b), spinning (c) and with an energy field extending up to a very large distance from the black hole (d). The boundary where this field coalesces is what we would experience as the radius of the particle.

All of the above means that we have to look for a charge having the same force as mass M. This originates what we would call the Planck charge Q:

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

In this equation ε_p is the Planck permittivity, already described in a previous paper [1], and can be calculated directly from Planck time:

$$\varepsilon_p \;=\; (t_p\,/\,4\,\pi^2)^{1/4} \tag{2}$$

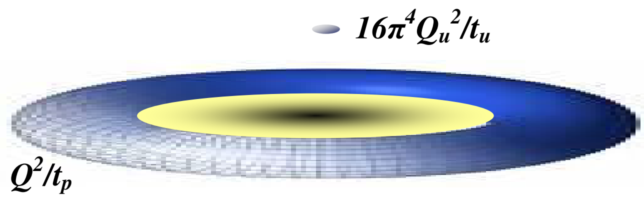
There is another factor to be taken in account in order to have a more comprehensive picture of our particle: its rotational speed u_0. We relate speed u_0 to the fine structure constant α_0 applicable to a Planck particle. We will call it the Planck fine structure constant or initial fine structure constant because it is going to be slightly different, by 0.02%, from the known constant:

$$\alpha_0 \;=\; 2\,(1 - u_0^2\,/\,c^2) \tag{3}$$

A link between the fine structure constant and the spinning speed has been proposed in the past [2] and has been precisely identified in a previous paper [3] by getting α_0 directly from basic constants:

$$\alpha_0 \;=\; 2\,\pi\,(\pi\,/\,c)^{3/2}\,(2\,G\,/\,h)^{1/4}\,(c\,/\,\pi\,h\,G)^{1/16} \tag{4}$$

Eq. 4 is dimensionally balanced because is the result of ratio $((16\pi^4 Q_u^2/t_u)/(Q^2/t_p))^{1/2}$ where Q_u and t_u are unitary charge and time respectively and must be always accounted for even if, numerically, it appears only as $16\pi^4$. The Coulomb was introduced in the measurement system without any thought to a future unification of electric and gravitational fields, but we still use it and a comparison with quantity $W_u=16\pi^4 Q_u^2/t_u$ is unavoidable. Now we know why the Planck mass could not be found: we were looking for a mass when in actual fact it was experienced as a charge that together with α_0 and ε_p fully characterize the Planck particle.



The power (J/sec) of the unitary charge, top, is exactly α_0^2 smaller than the power of our ring model for the black hole electron. The unit of charge, Coulomb, was devised without any relation with the quantum world and a confrontation is unavoidable as we are using the same units throughout.

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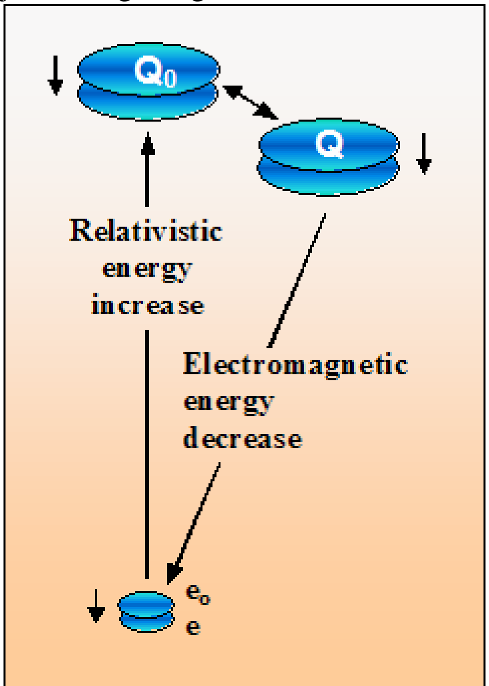
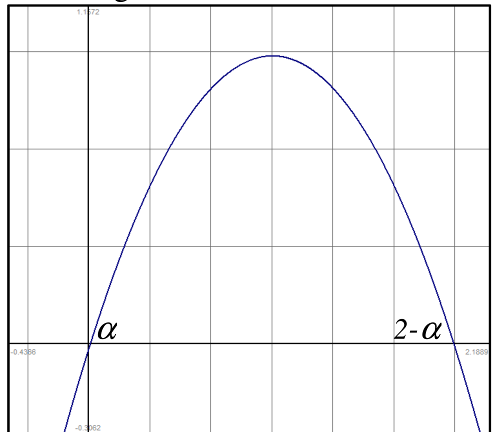
Electron charge and mass

The rotating charge Q will set up a magnetic field, which will tend to slow down the rotation of the charge itself. In other words, the magnetic force will subtract from the electric force and it will be this final force, still electric in nature, that we will be able to measure and associate to the initial electron charge e_0. Furthermore, the particle will experience a relativistic effect because its rotational speed is close to the speed of light. The energy increase of e_0 will result in a new charge $Q_0 = e_0/(1-u_0^2/c^2)^{1/2}$ slightly larger than Q so that $Q_0 = Q\ c/u_0$. What happens is that charge Q increases its value to Q_0 as a result of two opposing factors: a decrease due to the magnetic field induced by rotation yielding the measurable charge and an increase due to the relativistic factor giving, for instance, a more fitting value for permittivity $\varepsilon = Q_0^2/4hc$. We would identify this rotating particle as the initial electron as no interaction with virtual particles has been considered, as yet. Such interaction would have the effect to marginally decrease the rotational speed just enough to give us the known electron charge, see drawings.



Rotation of charge Q will set up a magnetic force which will subtract from the electric force leaving us a smaller charge e_0 which, in turn, is subjected to relativistic effects yielding Q_0 which behaves like charge Q giving again e_0. Finally, interaction with virtual particles would decrease the charges involved until we have the electron charge.



The equation linking α, h, G, c and e is plotted above, blue line. There are two solutions for the fine structure constant: α and $2\text{-}\alpha$. Both values would apply to the electron. Some experiments seem to confirm that there might be a second value for the fine structure constant close to 2.

When everything is taken in account we have the initial electron charge e_0 obtained directly from charge Q_0 and the initial fine structure constant α_0:

$$e_0 \;=\; Q_0\,(\alpha_0 / 2)^{1/2} \;=\; Q / (2 / \alpha_0 - 1)^{1/2} \qquad (5)$$

If all equations we have seen so far are put together we may formulate a new and interesting connection among basic constants:

$$\alpha_0^{\,2} - 2\,\alpha_0 + (2\,\pi)^4\,(\pi\,h\,G / c)^{1/2} / e_0^{\,2}\,c^2 \;=\; 0 \qquad (6)$$

The nice thing about the above equation, which we will call the *electron equation*, is that it is still applicable if we substitute α instead of α_0 and the current electron charge instead of e_0. In this way we are able, for example, to calculate G from very accurate constants or we may get the fine structure constant directly from other fundamental constants; actually we get two values: one is the known value and the other, $2\text{-}\alpha$, might play a part in some exotic electron properties [4].

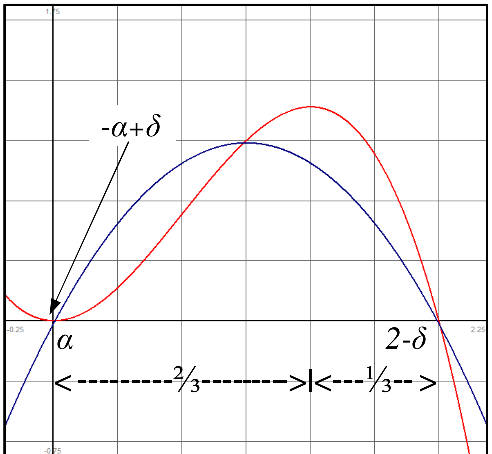
By substituting the electron charge with the equivalent classic expression showing it in terms of α, h, c and knowing that permittivity is $10^7/4\pi c^2$, we are able to devise another equation, which altogether removes the need to know the electron charge:

$$\alpha^3 - 2\,\alpha^2 + (2\,\pi)^5\,(\pi\,G / c^3\,h)^{1/2} / 10^7 \;=\; 0 \qquad (7)$$

We call this the *vacuum equation* as there is no direct reference to any physical object and will allow us to calculate the known fine structure directly from basic constants.

$(2\pi)^4$ which appears in both eq. 6 and 7 is quantity W_u already seen in the previous section. The electron charge is now calculated in many ways, for example from the initial charge e_0:

$$e \;=\; e_0\,((2 - \alpha_0)\,\alpha_0 \,/\, \alpha\,(2 - \alpha))^{1/2} \qquad (8)$$



There are three solutions for the vacuum equation, red line. There is a negative solution hinting at the possibility of a speed faster than light. $\delta = 2.65\text{x}10^{-5}$, see text at the end, is a quantity that simplifies calculations of the intercept points and the relative fine structure values. The curve max. divides the interval 0-2 in ⅔ and ⅓ exactly and might reflect a certain vacuum asymmetry.

If mass M is detected as charge Q where is then the gravitational mass?

Planck time t_p will allow only a small portion of the force to be detected outside the black hole. In the time window given by t_p we would have a gravitational force but in our everyday experience we would be totally unaware of this time window and the relevant time dimension will not appear in the force we measure. In practice we would have a gravitational force GM^2t_p but to our instruments it will simply look as a force $GM_0^{\,2}$:

$$G\,M_0^{\,2} \;=\; G\,M^2\,t_p \qquad (9)$$

If we apply the rotational factor as we did with the charge we get what we would call the initial electron mass m_b:

$$m_b \;=\; M_0\,(\alpha_0 \,/\, 2)^{1/2}\;\;(1\text{-}\,\alpha_0 \,/\, 2)^{3/8} \qquad (10)$$

Term $(1\text{-}\alpha_0/2)^{3/8}$ would represent the decrease of the 3 torus radii due to rotation at relativistic speed. The result is 0.25% close to the known electron mass. If we apply the interaction with virtual particles, thus changing α_0 to α and a correcting factor related to the radii variation of the ring and ring section, thus increasing each radius by the term $(\alpha/\alpha_0)^4$, we have our electron mass m_e:

$$m_e \;=\; M_0\,(\alpha/2)^{1/2}\,(1\text{-}\alpha/2)^{3/8}\,(\alpha/\alpha_0)^{12}\,((2\text{-}\alpha)/(2\text{-}\alpha_0))^{1/4} \qquad (11)$$

There is also an addition term $(u_e/u_0)^{1/2} = ((2\text{-}\alpha)/(2\text{-}\alpha_0))^{1/4}$ which describes the speed variation from the initial speed u_0 to the final, and lower, speed u_e. The conclusion is now obvious: Planck mass M is part of every electron, it is the electron itself and surely we have plenty of them around. But there is another particle, the neutrino, which seems to have the same origin with the difference that the rotational speed is equal to the speed of light c.

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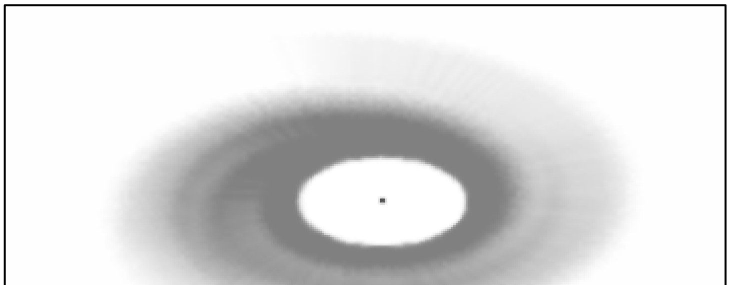
Neutrino and mass decrease

The detailed equation leading to the initial electron charge is based on the forces acting on the Planck particle when it is spinning:

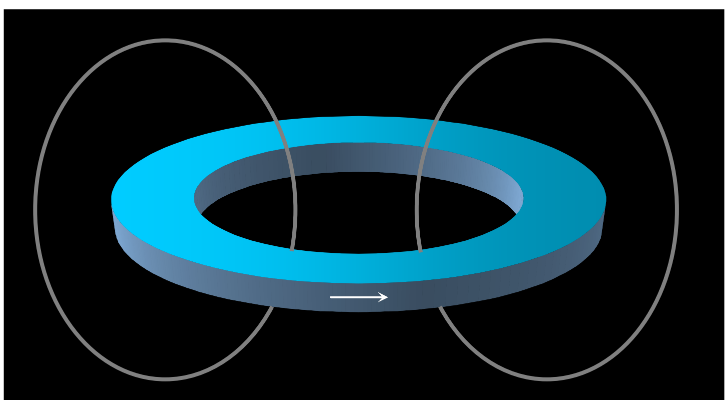
$$Q_0^2 / 4 \pi \varepsilon - \mu Q_0^2 u_0^2 / 4 \pi = e_0^2 / 4 \pi \varepsilon \qquad (12)$$

The term on the left includes the electric force of charge Q_0 and the magnetic force generated by the same charge when rotating at speed u_0 and working against the electric force. Here ε is the permittivity applicable to the initial electron charge and is equal to $Q_0^2/4hc$; if Q_0 changes, the associated permittivity will change as well. As $\mu = 1/\varepsilon c^2$ we see that if we speed up the particle to c the left side goes to zero and so does the fine structure constant. We are left with no charge and no mass. The faster we spin the particle, the lower will be its measurable charge and mass and if rotation takes place at exactly speed c, we have a particle that could be safely identified with the neutrino. A mass, however small, will be shown by the neutrino if the speed is not exactly c. We might even have a sort of speed oscillation leading to a mass oscillation.



How would you envisage something with no mass, no charge, of unknown size, yet, it is spinning? A gray whirl is the best our imagination can figure out for the neutrino.

The interesting question is whether we can apply this same mass decrease to our physical world: first of all it would apply to charged objects and the mass decrease would be given by the factor $(1-u^2/c^2)^{1/2}$ where u is the rotational speed; this works out to be exactly the opposite of the mass increase when the relativistic factor is applied. The problem is that the object will fly apart due to the centrifugal force before we are able to detect any small change. A possible solution is to endow it with a strong magnetic field from a superconductive ring opposing the electric force as suggested by eq. 12. Under these circumstances we might be able to measure what would amount to a weight decrease of the fast rotating ring without the need to rotate it at prohibitively high speed.



The magnetic field of a fast rotating superconductive ring would bring about a tiny weight decrease of the ring itself. The technical problems connected with such a delicate measurement could prove quite difficult to overcome and experiments conducted in the past have given conflicting results.

Early experiments conducted by Podkletnov in Finland in 1992 were based on the detection of an allegedly gravitational shield. But from the above it does not appear that there is such a "shielding" effect but just a weight decrease of the material under test.

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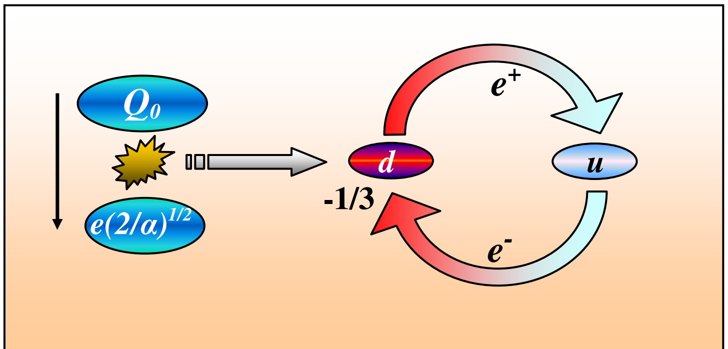
Quark charge

When calculating the electron charge we found that its measurable charge could have been the result of interaction with virtual particles: such interaction would bring about a slowdown of the rotational speed, an increase of the fine structure constant and permittivity and a decrease of all charge values involved such as Q, Q_0 and e_0. Specifically, charge Q_0 decreases to a lower value given by $e(2/\alpha)^{1/2}$. Where did the excess charge go?



Because of the interaction with virtual particles, charge Q_0 decreases its value and the difference is the d-quark charge. It was not possible to get the u-quark charge directly and it is inferred that the + ⅔ charge is the result of further interaction with virtual particles.

We suggest the hypothesis that this charge difference is the one originating the d-quark charge d_q calculated as follows:

$$d_q \;=\; (Q_0^{\,2} - 2\, e^2 / \alpha)^{1/2} \tag{13}$$

We normally assign the d-quark charge ⅓ the electron charge. In our case, charge d_q is not exactly ⅓ but shows a difference of 0.07%. There might be secondary effects, such as a small variation of the rotational speed not taken in account or, more likely, eq. 13 is an approximation of a more complex equation. In addition, it was not possible to find the u-quark charge, normally given at ⅔ the electron charge, so it is inferred that the u-quark charge is somehow the result of interaction of the d-quark with virtual particles as shown in the above drawing. This quark charge asymmetry might be reflected by the vacuum equation where there is a ⅔ and ⅓ asymmetry in the plotted curve.

Quarks are associated with the strong force and the relevant fine structure constant is no longer α but should be close to 1. We have related the rotational speed to the fine structure constant and if we execute a new calculation following a similar procedure to the one used for the initial electron mass m_b but with the fine structure constant equal to 1, we find that the resulting particle rotates at a lower speed $u_q = c/2^{1/2}$ and has a mass of 4.6 MeV or 9 times the electron mass. This value is within current estimate for the d-quark mass which is between 4.5 and 5.5 MeV.

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Conclusion

The Planck mass is actually an all-pervasive particle. It would be the one originating the mass and charge of the electron, the neutrino and, indirectly, the quark. It is so much bigger than any known particle that it was necessary to invoke the strong gravity to justify

its existence, yet it was there with us all the time: its behavior in our world was that of a charge not a mass.
The table below shows the main numerical results for the most important equations.

Initial data		
c = 299792458 h = 6.62606944283x10^{-34} G = 6.672918952267x10^{-11}		
Planck parameters		
Planck time t_p	$(\pi\, h\, G / c^5)^{1/2}$	2.3950197x10^{-43}
Planck mass M	$h / t_p\, c^2$	3.0782613x10^{-8}
Planck permit. ε_p	$(t_p / 4\,\pi^2)^{1/4}$	8.825459772x10^{-12}
Planck charge Q	$M\,(4\,\pi\,\varepsilon_p\, G)^{1/2}$	2.648116x10^{-18}
Unitary energy in unitary time W_u	$16\,\pi^4\, Q_u^{\,2} / t_u$	1558.5454565
Planck or initial fine struct. const. α_0	$2\pi\,(\pi/c)^{3/2}\,(2G/h)^{1/4}\,(c/\pi hG)^{1/16}$	7.295873175x10^{-3}
Initial electron charge e_0	$Q / (2 / \alpha_0 - 1)^{1/2}$	1.60233838x10^{-19}
Electron and d-quark		
Vacuum equation Fine structure constants α	Solve: $\alpha^3 - 2\,\alpha^2 + (2\pi)^5\,(\pi\, G/c^3\, h)^{1/2} / 10^7 = 0$	7.2973525719x10^{-3} 1.999973470767 -7.270823339x10^{-3}
Electron charge e	$e_0\,((2 - \alpha_0)\,\alpha_0 / \alpha\,(2 - \alpha))^{1/2}$	1.602176549x10^{-19}
Electron equation fine struct. const. α	Solve: $\alpha^2 - 2\,\alpha + (2\pi)^4\,(\pi hG/c)^{1/2} / e^2\, c^2 = 0$	7.2973525719x10^{-3} 1.99270264743
Mass m_e	$M(t_p\,\alpha/2)^{1/2}(\alpha/\alpha_0)^{12}(1-\alpha/2)^{3/8}((2-\alpha)/(2-\alpha_0))^{1/4}$	9.10938272x10^{-31}
D-quark charge d_q	$(2\, e_0^{\,2} / \alpha_0 - 2\, e^2 / \alpha)^{1/2}$	5.336856x10^{-20}

All numbers are within one standard deviation (Codata 2010), with the exception of G at 1.15 standard deviations and the d-quark charge which is 0.07% smaller than expected.
Despite the basic and somewhat elementary model used, we have seen that no other constant is required except c, h and G in order to have our particle; this is a further confirmation that Planck quantities are indeed all we need to build our world.
In some cases we have experienced an apparent change of dimension: for example, time t_p is part of the electron mass but we have no experience of it. The ratio of the gravitational to the electric force in an electron looks to us as a dimensionless ratio but actually it has a time dimension. Our inability to properly take in account time t_p has a domino effect on the dimensions of many quantities. Some equations in the above table may seem dimensionally unmatched at first, but we must not forget that quantity $(2\pi)^4$ is actually W_u thus providing the balancing factor and the connection among hitherto unrelated constants.
All possible fine structure constants given by our equations are summarized in the table below.

Quantity $\delta = 2.653 \times 10^{-5}$ was introduced in order to simplify calculations and it is obtained directly from α:

Fine structure	negative value	standard value	up value
Planck	*no*	α_0	$2 - \alpha_0$
Electron	*no*	α	$2 - \alpha$
Vacuum	$-\alpha + \delta$	α	$2 - \delta$
Spin speed	$u > c$	$u < c$	$u << c$

$$\delta \;=\; 1 + \alpha / 2 - (1 + \alpha - 3\alpha^2/4)^{1/2} \qquad (14)$$

Of course, both the negative and what we call the *up* value [4] originate from the vacuum equation. Another puzzling aspect is the possibility of a speed faster than light. Eq. 7 gives also a negative fine structure constant and from eq. 3 we get a speed 0.18% faster than *c*. A speed faster than light seems to be merely a peculiarity of vacuum and would not apply to any particle with mass; yet, the presence of a negative fine structure and the intrinsic asymmetry of the vacuum equation seems to indicate a rather complex underlying structure populated by weird immaterial particles, where the property of the Dirac sea of virtual particles could be just an approximation.

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