

# Programming Mass, Space, Time in a Virtual "Computer Universe" Simulation via a black-hole electron and Planck momentum

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In this article I describe a method for programming the physical Planck units of Planck mass, Planck length, Planck time, Planck momentum, charge and temperature within a virtual "computer universe" simulation. I use a dimensionless electron formula ( $f_e = 4\pi^2 r^3$ ;  $r = 2^6 3\pi^2 \alpha \Omega^5$ , units = 1) which embeds these base units as simple geometrical forms (mass  $M=1$ , time  $T=2\pi$ , length  $L=2\pi^2 \Omega^2 \dots$ ). It is the geometry which incorporates the functionality of the unit, thus resolving the principal difficulty of mathematical universe hypotheses as being how to relate mathematical forms to their corresponding physical units. I then demonstrate how these geometries can be used to solve the physical constants  $G, h, c, e, m_e, k_B$  using 2 mathematical constants (the fine structure constant  $\alpha$  and a recurring number  $\Omega$ ) and 2 scalars ( $r, v$ ) to convert to their respective SI values. The 5 SI units  $kg, m, s, A, k$  are reduced to exponents of a single unit  $u$ . Results are consistent with CODATA 2014 yet I am using only 2 constants, 2 scalar variables and 1 unit;  $\alpha, \Omega, r, v, u$ . The rationale for the electron formula was derived via the sqrt of Planck momentum and a black-hole electron model as a function of magnetic-monopoles and time. As the physical constants and units can be treated as mathematical objects they may be reproduced algorithmically within a simulation environment, the unit  $u$  representing a rule-based set rather than a physical unit.

Table 1	Calculated	CODATA 2014
Fine structure constant alpha	(137.035999 139)	$\alpha = 137.035\ 999\ 139(31)$ [18]
Rydberg constant	(10973731.568 508)	$R_\infty = 10\ 973\ 731.568\ 508(65)$ [15]
Planck constant	$h^* = 6.626\ 069\ 134\ e-34$	$h = 6.626\ 070\ 040(81)\ e-34$ [16]
Elementary charge	$e^* = 1.602\ 176\ 511\ 30\ e-19$	$e = 1.602\ 176\ 6208(98)\ e-19$ [19]
Electron mass	$m_e^* = 9.109\ 382\ 312\ 56\ e-31$	$m_e = 9.109\ 383\ 56(11)\ e-31$ [17]
Boltzmann's constant	$k_B^* = 1.379\ 510\ 147\ 52\ e-23$	$k_B = 1.380\ 648\ 52(79)\ e-23$ [22]
Gravitation constant	$G^* = 6.672\ 497\ 192\ 29\ e-11$	$G = 6.674\ 08(31)\ e-11$ [21]

keywords: computer universe, virtual universe, mathematical universe, simulated universe, Planck momentum, Planck unit, magnetic-monopole, fine structure constant alpha, Omega, black-hole electron, sqrt Planck momentum;

## 1 Background

The general universe simulation hypothesis proposes that all of reality, including the earth and the universe, is in fact an artificial simulation, analogous to a computer simulation, and as such our reality is an illusion [2].

Mathematical platonism is a metaphysical view that there are abstract mathematical objects whose existence is independent of us [1]. Mathematical realism holds that mathematical entities exist independently of the human mind. Thus humans do not invent mathematics, but rather discover it. Triangles, for example, are real entities, not the creations of the human mind [3].

Max Tegmark's Mathematical Universe Hypothesis: Our external physical reality is a mathematical structure. That is, the physical universe is mathematics in a well-defined sense, and "in those [worlds] complex enough to contain self-aware substructures [they] will subjectively perceive themselves as existing in a physically 'real' world" [10].

Planck units are a set of units of measurement also known as natural units because the origin of their definition comes

only from properties of nature and not from any human construct. The base units are Planck mass, Planck time, Planck length, Planck charge, Planck temperature.

## 2 Introduction

Mathematical universe hypotheses presume that our physical universe has an underlying mathematical origin. The principal difficulty of such hypotheses is the problem of constructing physical units such as mass, space and time from their respective mathematical forms.

This article describes a mathematical universe model that uses geometrical forms to duplicate the functionality of the unit. These geometrical objects are constructed from 2 mathematical constants; the fine structure constant  $\alpha$  and a presumed constant  $\Omega$ . The 5 SI units  $kg, m, s, A, k$  are replaced by a single unit  $u$ . To solve the constants  $G, h, c, e, m_e, k_B$  in SI terms also requires 2 scalars to convert from the base geometries to their respective SI values. Results are consistent with CODATA 2014 (see table).

Geometries (mass  $M=1$ , time  $T=2\pi$ , length  $L=2\pi^2 \Omega^2 \dots$ )

are embedded within a virtual electron  $f_e = 4\pi^2(2^6 3\pi^2 \alpha \Omega^5)^3$ , units = 1. As these geometries overlap in the electron, the units of mass, space and time are not independent of each other, and so we can for example create mass as long as we create the equivalent space and time to balance our mass space time ratio;  $M^9 T^{11} / L^{15}$  units = 1. This also means that we can define mass in terms of space and time  $M^9 = L^{15} / T^{11}$  (i.e.: if we know the values for Planck length and Planck time then we can calculate Planck mass).

I submit that it is possible to duplicate the physical units of mass, space, time and charge using mathematical forms and that these forms, being geometrical, can be represented algorithmically.

In section 3. I derive the rationale for a virtual electron based on the SI units. In section 4. I use this virtual electron to construct those geometrical forms.

### 3 Virtual electron

In this section I introduce the sqrt of momentum and suggest how this could be used as a link between the mass and charge domains such that we can then reduce the number of base SI units from 5 (kg, m, s, A, K) to 2.

From the formulas for the charge constants I then derive a formula for a magnetic monopole (ampere-meter AL) and from this subsequently a formula for an electron function  $f_e$ .

The electron formula is constructed from monopoles (AL) and from time T yet it is also dimensionless as the charge and time units are not independent but rather are related, collapsing within the electron whereby;  $f_e = (AL)^3 / T$ , units = 1. Being dimensionless and so independent of any system of units, this electron formula is a mathematical constant.

By reducing the number of physical units, it becomes possible to redefine the least precise of the physical constants  $G, h, e, m_e, k_B$  in terms of the 4 most precise  $c, \mu_0$  (exact values), Rydberg  $R$  (12 digit precision) and  $\alpha$  (10 digit precision). See table p1.

Note: for convenience I use the commonly recognized value for alpha as  $\alpha \sim 137.036$  instead of its inverse.

Defining  $Q$  as the sqrt of Planck momentum where Planck momentum =  $m_P c = 2\pi Q^2 = 6.52485... \text{ kg.m/s}$ , and a unit  $q$  whereby  $q^2 = \text{kg.m/s}$  giving;

$$Q = 1.019\ 113\ 411..., \text{ unit} = q \quad (1)$$

$$\begin{aligned} \text{Planck momentum; } 2\pi Q^2, \text{ units} &= q^2, \\ \text{Planck length; } l_p, \text{ units} &= m = q^2 s / \text{kg}, \\ c, \text{ units} &= m/s = q^2 / \text{kg}; \end{aligned}$$

3.1. In Planck terms the mass constants are typically defined in terms of Planck mass, here I use Planck momentum;

$$m_P = \frac{2\pi Q^2}{c}, \text{ unit} = \text{kg} \quad (2)$$

$$E_P = m_P c^2 = 2\pi Q^2 c, \text{ units} = \frac{\text{kg.m}^2}{s^2} = \frac{q^4}{\text{kg}} \quad (3)$$

$$t_p = \frac{2l_p}{c}, \text{ unit} = s \quad (4)$$

$$F_p = \frac{2\pi Q^2}{t_p}, \text{ units} = \frac{q^2}{s} \quad (5)$$

3.2. The charge constants in terms of  $Q^3, c, \alpha, l_p$ ;

$$A_Q = \frac{8c^3}{\alpha Q^3}, \text{ unit } A = \frac{m^3}{q^3 s^3} = \frac{q^3}{\text{kg}^3} \quad (6)$$

$$e = A_Q t_p = \frac{8c^3}{\alpha Q^3} \cdot \frac{2l_p}{c} = \frac{16l_p c^2}{\alpha Q^3}, \text{ units} = A.s = \frac{q^3 s}{\text{kg}^3} \quad (7)$$

$$T_p = \frac{A_Q c}{\pi} = \frac{8c^3}{\alpha Q^3} \cdot \frac{c}{\pi} = \frac{8c^4}{\pi \alpha Q^3}, \text{ units} = \frac{q^5}{\text{kg}^4} \quad (8)$$

$$k_B = \frac{E_P}{T_p} = \frac{\pi^2 \alpha Q^5}{4c^3}, \text{ units} = \frac{\text{kg}^3}{q} \quad (9)$$

3.3. As with  $c$ , the permeability of vacuum  $\mu_0$  has been assigned an exact numerical value so it is our next target. The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross section, and placed 1 meter apart in vacuum, would produce between these conductors a force equal to exactly  $2.10^{-7}$  newton per meter of length.

$$\frac{F_{electric}}{A_Q^2} = \frac{F_p}{\alpha} \cdot \frac{1}{A_Q^2} = \frac{2\pi Q^2}{\alpha t_p} \cdot \left(\frac{\alpha Q^3}{8c^3}\right)^2 = \frac{\pi \alpha Q^8}{64l_p c^5} = \frac{2}{10^7} \quad (10)$$

$$\mu_0 = \frac{\pi^2 \alpha Q^8}{32l_p c^5} = \frac{4\pi}{10^7}, \text{ units} = \frac{\text{kg.m}}{s^2 A^2} = \frac{\text{kg}^6}{q^4 s} \quad (11)$$

3.4. Rewriting Planck length  $l_p$  in terms of  $Q, c, \alpha, \mu_0$ ;

$$l_p = \frac{\pi^2 \alpha Q^8}{32\mu_0 c^5}, \text{ unit} = \frac{q^2 s}{\text{kg}} = m \quad (12)$$

3.5. A magnetic monopole in terms of  $Q, c, \alpha, l_p$ ;

The ampere-meter is the SI unit for pole strength (the product of charge and velocity) in a magnet ( $Am = ec$ ). A magnetic monopole  $\sigma_e$  is a hypothetical particle that is a magnet with only 1 pole [12]. I propose a magnetic monopole  $\sigma_e$  from  $\alpha, e, c$  ( $\sigma_e = 0.13708563 \times 10^{-6}$ );

$$\sigma_e = \frac{3\alpha^2 ec}{2\pi^2}, \text{ units} = \frac{q^5 s}{\text{kg}^4} \quad (13)$$

I then use this monopole to construct an electron frequency function  $f_e$  ( $f_e = 0.2389545 \times 10^{23}$ );

$$f_e = \frac{\sigma_e^3}{t_p} = \frac{2^8 3^3 \alpha^3 l_p^2 c^{10}}{\pi^6 Q^9} = \frac{3^3 \alpha^5 Q^7}{4\pi^2 \mu_0^2}, \text{ units} = \frac{q^{15} s^2}{\text{kg}^{12}} \quad (14)$$

3.6. The most precisely measured of the natural constants is the Rydberg constant  $R_\infty$  (see table) and so it is important to this model. The unit for  $R_\infty$  is  $1/m$ . For  $m_e$  see eq(22);

$$R_\infty = \frac{m_e e^4 \mu_0^2 c^3}{8h^3} = \frac{2^5 c^5 \mu_0^3}{3^3 \pi \alpha^8 Q^{15}}, \text{ units} = \frac{1}{m} = \frac{\text{kg}^{13}}{q^{17} s^3} \quad (15)$$

This however now gives us 2 solutions for length  $m$ , see eq(1) and eq(15), if they are both valid then there must be a ratio whereby the units  $q, s, kg$  overlap and cancel;

$$m = \frac{q^2 s}{kg} \cdot \frac{q^{15} s^2}{kg^{12}} = \frac{q^{17} s^3}{kg^{13}}; \text{ thus } \frac{q^{15} s^2}{kg^{12}} = 1 \quad (16)$$

and so we can further reduce the number of units required, for example we can define  $s$  in terms of  $kg, q$ ;

$$s = \frac{kg^6}{q^{15/2}} \quad (17)$$

$$\mu_0 = \frac{kg^6}{q^4 s} = q^{7/2} \quad (18)$$

3.7. We find that this ratio is embedded in that electron function  $f_e$  (eq 14), and so  $f_e$  is a dimensionless mathematical constant whose function appears to be dictating the frequency of the Planck units;

$$f_e = \frac{\sigma_e^3}{t_p}; \text{ units} = \frac{q^{15} s^2}{kg^{12}} = 1 \quad (19)$$

Replacing  $q$  with the more familiar  $m$  gives this ratio;

$$q^2 = \frac{kg \cdot m}{s}; q^{30} = \left(\frac{kg \cdot m}{s}\right)^{15} = \frac{kg^{24}}{s^4} \quad (20)$$

$$\text{units} = \frac{kg^9 s^{11}}{m^{15}} = 1 \quad (21)$$

Electron mass as frequency of Planck mass:

$$m_e = \frac{m_p}{f_e}, \text{ unit} = kg \quad (22)$$

Electron wavelength via Planck length:

$$\lambda_e = 2\pi l_p f_e, \text{ units} = m = \frac{q^2 s}{kg} \quad (23)$$

Gravitation coupling constant:

$$\alpha_G = \left(\frac{m_e}{m_p}\right)^2 = \frac{1}{f_e^2}, \text{ units} = 1 \quad (24)$$

3.8. The Rydberg constant  $R_\infty = 10973731.568508(65)$  [15] has been measured to a 12 digit precision. The known precision of Planck momentum and so  $Q$  is low, however with the solution for the Rydberg eq(15) we may re-write  $Q$  as  $Q^{15}$  in terms of;  $c, \mu_0, R$  and  $\alpha$ ;

$$Q^{15} = \frac{2^5 c^5 \mu_0^3}{3^3 \pi \alpha^8 R}, \text{ units} = \frac{kg^{12}}{s^2} = q^{15} \quad (25)$$

Using the formulas for  $Q^{15}$  eq(25) and  $l_p$  eq(12) we can re-write the least accurate dimensioned constants in terms of the

most accurate constants;  $R, c, \mu_0, \alpha$ . I first convert the constants until they include a  $Q^{15}$  term which can then be replaced by eq(25). Setting unit  $x$  as;

$$\text{unit } x = \frac{kg^{12}}{q^{15} s^2} = 1 \quad (26)$$

Elementary charge  $e = 1.602\ 176\ 51130\ \text{e-19}$  (table p1)

$$e = \frac{16 l_p c^2}{\alpha Q^3} = \frac{\pi^2 Q^5}{2 \mu_0 c^3}, \text{ units} = \frac{q^3 s}{kg^3} \quad (27)$$

$$e^3 = \frac{\pi^6 Q^{15}}{8 \mu_0^3 c^9} = \frac{4 \pi^5}{3^3 c^4 \alpha^8 R}, \text{ units} = \frac{kg^3 s}{q^6} = \left(\frac{q^3 s}{kg^3}\right)^3 \cdot x \quad (28)$$

Planck constant  $h = 6.626\ 069\ 134\ \text{e-34}$

$$h = 2\pi Q^2 2\pi l_p = \frac{4\pi^4 \alpha Q^{10}}{8 \mu_0 c^5}, \text{ units} = \frac{q^4 s}{kg} \quad (29)$$

$$h^3 = \left(\frac{4\pi^4 \alpha Q^{10}}{8 \mu_0 c^5}\right)^3 = \frac{2\pi^{10} \mu_0^3}{3^6 c^5 \alpha^{13} R^2}, \text{ units} = \frac{kg^{21}}{q^{18} s} = \left(\frac{q^4 s}{kg}\right)^3 \cdot x^2 \quad (30)$$

Boltzmann constant  $k_B = 1.379\ 510\ 14752\ \text{e-23}$

$$k_B = \frac{\pi^2 \alpha Q^5}{4 c^3}, \text{ units} = \frac{kg^3}{q} \quad (31)$$

$$k_B^3 = \frac{\pi^5 \mu_0^3}{3^3 2 c^4 \alpha^5 R}, \text{ units} = \frac{kg^{21}}{q^{18} s^2} = \left(\frac{kg^3}{q}\right)^3 \cdot x \quad (32)$$

Gravitation constant  $G = 6.672\ 497\ 19229\ \text{e-11}$

$$G = \frac{c^2 l_p}{m_p} = \frac{\pi \alpha Q^6}{64 \mu_0 c^2}, \text{ units} = \frac{q^6 s}{kg^4} \quad (33)$$

$$G^5 = \frac{\pi^3 \mu_0}{2^{20} 3^6 \alpha^{11} R^2}, \text{ units} = kg^4 s = \left(\frac{q^6 s}{kg^4}\right)^5 \cdot x^2 \quad (34)$$

Planck length

$$l_p^{15} = \frac{\pi^{22} \mu_0^9}{2^{35} 3^{24} c^{35} \alpha^{49} R^8}, \text{ units} = \frac{kg^{81}}{q^{90} s} = \left(\frac{q^2 s}{kg}\right)^{15} \cdot x^8 \quad (35)$$

Planck mass

$$m_p^{15} = \frac{2^{25} \pi^{13} \mu_0^6}{3^6 c^5 \alpha^{16} R^2}, \text{ units} = kg^{15} = \frac{kg^{39}}{q^{30} s^4} \cdot \frac{1}{x^2} \quad (36)$$

Electron mass  $m_e = 9.109\ 382\ 31256\ \text{e-31}$

$$m_e^3 = \frac{16 \pi^{10} R \mu_0^3}{3^6 c^8 \alpha^7}, \text{ units} = kg^3 = \frac{kg^{27}}{q^{30} s^4} \cdot \frac{1}{x^2} \quad (37)$$

Ampere

$$A_Q^5 = \frac{2^{10} \pi^3 c^{10} \alpha^3 R}{\mu_0^3}, \text{ units} = \frac{q^{30} s^2}{kg^{27}} = \left(\frac{q^3}{kg^3}\right)^5 \cdot \frac{1}{x} \quad (38)$$

### 3.9. ( $r = \sqrt{q}$ )

There is a solution for an  $r^2 = q$ , it is the radiation density constant from the Stefan Boltzmann constant  $\sigma$ ;

$$\sigma = \frac{2\pi^5 k_B^4}{15h^3 c^2}, \quad r_d = \frac{4\sigma}{c}, \quad \text{units} = r \quad (39)$$

$$r_d^3 = \frac{3^3 4\pi^5 \mu_0^3 \alpha^{19} R^2}{5^3 c^{10}}, \quad \text{units} = \frac{kg^{30}}{q^{36} s^5} \cdot \frac{1}{x^2} = \frac{kg^6}{q^6 s} = r^3 \quad (40)$$

## 4 Geometrical units

4.1. The formula for the electron  $f_e$  incorporates dimensionful quantities but itself is dimensionless. This means that its numerical value is a mathematical constant, independent of which set of units we may use;  $f_e = .23895453... \times 10^{23}$ . Setting  $T = t_p$ ,  $A = eT$ ,  $V = 2l_p/T$ ;

$$f_e = \left(\frac{3\alpha^2 ATV}{2\pi^2}\right)^3 \frac{1}{T} = 0.239 \times 10^{23}, \quad \text{unit} = 1 \quad (41)$$

Because the numerical value is fixed and units = 1, we can look for other, non SI sets of ATV units which can also be used to solve  $f_e$ . In this section I describe 1 solution that constructs the base units from a geometrical component in terms of 2 fixed dimensionless mathematical constants; the fine structure constant alpha and a proposed Omega (4.5), from 2 variable unit-dependent scalars (from the list *ktlvpa*), and a unit  $u$  that replaces the SI units ( $kg, m, s, A, k$ ).

$$M = (1)k, \quad \text{unit} = u^{15} \text{ (mass)} \quad (42)$$

$$T = (2\pi)t, \quad \text{unit} = u^{-30} \text{ (time)} \quad (43)$$

$$P = (\Omega)p, \quad \text{unit} = u^{16} \text{ (sqrt of momentum)} \quad (44)$$

$$V = (2\pi\Omega^2)v, \quad \text{unit} = u^{17} \text{ (velocity)} \quad (45)$$

$$L = (2\pi^2\Omega^2)l, \quad \text{unit} = u^{-13} \text{ (length)} \quad (46)$$

$$A = \left(\frac{2^6\pi^3\Omega^3}{\alpha}\right)a, \quad \text{unit} = u^3 \text{ (ampere)} \quad (47)$$

4.2 In the previous section we used only 2 base units to define the others. In this example I use  $P, V$  to derive  $MLTA$  and then the physical constants. Scaling  $p, v$  to their SI values gives  $M=m_p, L=l_p, T=t_p, V=c, P=Q$

$$P = (\Omega)p, \quad \text{unit} = u^{16} \quad (48)$$

$$V = (2\pi\Omega^2)v, \quad \text{unit} = u^{17} \quad (49)$$

$$M = \frac{2\pi P^2}{V} = (1)\frac{P^2}{v}, \quad \text{unit} = u^{16*2-17*15} \quad (50)$$

$$T^2 = (2\pi\Omega)^{15} \frac{P^9}{2\pi V^{12}} \quad (51)$$

$$T = (2\pi)\frac{P^{9/2}}{v^6}, \quad \text{unit} = u^{16*9/2-17*6=-30} \quad (52)$$

$$L = \frac{TV}{2} = (2\pi^2\Omega^2)\frac{P^{9/2}}{v^5}, \quad \text{unit} = u^{16*9/2-17*5=-13} \quad (53)$$

$$A = \frac{8V^3}{\alpha P^3} = \left(\frac{2^6\pi^3\Omega^3}{\alpha}\right)\frac{v^3}{P^3}, \quad \text{unit} = u^{17*3-16*3=3} \quad (54)$$

For convenience here I assign  $r = \sqrt{p}$ , unit  $u^{16/2=8}$ ;

$$G^* = \frac{V^2 L}{M} = 2^3\pi^4\Omega^6\frac{r^5}{v^2}, \quad u^{34-13-15=8*5-17*2=6} \quad (55)$$

$$h^* = 2\pi MVL = 2^3\pi^4\Omega^4\frac{r^{13}}{v^5}, \quad u^{15+17-13=8*13-17*5=19} \quad (56)$$

$$T_P^* = \frac{AV}{\pi} = \frac{2^7\pi^3\Omega^5}{\alpha}\frac{v^4}{r^6}, \quad u^{3+17=17*4-6*8=20} \quad (57)$$

$$e = AT = \frac{2^7\pi^4\Omega^3}{\alpha}\frac{r^3}{v^3}, \quad u^{3-30=3*8-17*3=-27} \quad (58)$$

$$k_B^* = \frac{\pi VM}{A} = \frac{\alpha}{2^5\pi\Omega}\frac{r^{10}}{v^3}, \quad u^{17+15-3=10*8-17*3=29} \quad (59)$$

$$\mu_0^* = \frac{\pi V^2 M}{\alpha LA^2} = \frac{\alpha}{2^{11}\pi^5\Omega^4}\frac{r^7}{v^7}, \quad u^{17*2+15+13-6=7*8=56} \quad (60)$$

$$\epsilon_0^{*-1} = \frac{\alpha}{2^9\pi^3}\frac{v^2 r^7}{v^7}, \quad u^{34+56=90} \quad (61)$$

$$r_\sigma^* = \left(\frac{8\pi^5 k_B^4}{15h^3 c^3}\right) = \frac{\alpha}{2^{29}15\pi^{14}\Omega^{22}}r, \quad u^{29*4-19*3-17*3=8} \quad (62)$$

$$R^* = \left(\frac{m_e}{4\pi l_p \alpha^2 m_p}\right) = \frac{1}{2^{23}3^3\pi^{11}\alpha^5\Omega^{17}}\frac{v^5}{r^9}, \quad u^{13} \quad (63)$$

Scalars  $r, v$  were chosen as they can be determined directly from  $c, \mu_0$  (eq 49, 60);

$$v = \frac{c}{2\pi\Omega^2} \quad (64)$$

$$r^7 = \frac{2^6\pi^6\Omega^4}{5^7\alpha} \quad (65)$$

In those (electron) ratios the scalar numerical values and units cancel. Using SI Planck units  $M = m_p, T = t_p, L = l_p$  (4.1);

$$\frac{L^{15}}{M^9 T^{11}} = \frac{l_p^{15}}{m_p^9 t_p^{11}} = \frac{(2\pi^2\Omega^2)^{15}}{(1)^9(2\pi)^{11}} \cdot \frac{l_p^{15}}{k^9 t^{11}} = 2^4\pi^{19}\Omega^{30} \quad (66)$$

$$\frac{l^{15}}{k^9 t^{11}} = \frac{(.20322087^{-36})^{15}}{(.217672818^{-7})^9(.171585513^{-43})^{11}} \frac{u^{-13*15}}{u^{15*9}u^{-30*11}} = 1 \quad (67)$$

$$\frac{A^3 L^3}{T} = \frac{A_Q^3 l_p^3}{t_p} = \frac{(2^6\pi^3\Omega^3)^3(2\pi^2\Omega^2)^3}{(\alpha^3(2\pi))} \cdot \frac{a^3 l^3}{t} = \frac{2^{20}\pi^{14}\Omega^{15}}{\alpha^3} \quad (68)$$

$$\frac{a^3 l^3}{t} = \frac{(.12691859^{23})^3(.20322087^{-36})^3}{(.171585513^{-43})} \frac{u^{3*3}u^{-13*3}}{u^{-30}} = 1 \quad (69)$$

4.3. The electron function  $f_e$  is both unit-less and non scalable  $v^0 r^0 u^0 = 1$ . It is therefore a natural (mathematical) constant.

$$\sigma_e = \frac{3\alpha^2 AL}{\pi^2} = 2^7 3\pi^3 \alpha \Omega^5 \frac{r^3}{v^2}, \quad u^{-10} \quad (70)$$

$$f_e = \frac{\sigma_e^3}{T} = 4\pi^2(2^6 3\pi^2 \alpha \Omega^5)^3, \text{ units} = \frac{u^{30}}{(u^{10})^3} = 1 \quad (71)$$

$$\sigma_{tp} = \frac{3\alpha^2 T_P}{2\pi} = 2^6 3\pi^2 \alpha \Omega^5 \frac{v^4}{r^6}, \text{ units} = u^{20} \quad (72)$$

$$f_e = t_p^2 \sigma_{tp}^3 = 4\pi^2(2^6 3\pi^2 \alpha \Omega^5)^3, \text{ units} = \frac{(u^{20})^3}{(u^{30})^2} = 1 \quad (73)$$

4.4. The Sommerfeld fine structure constant alpha is a dimensionless mathematical constant. The following use a well known formula for alpha;

$$\alpha = \frac{2h}{\mu_0 e^2 c} = 2.2\pi Q^2 2\pi l_p \cdot \frac{32l_p c^5}{\pi^2 \alpha Q^8} \cdot \frac{\alpha^2 Q^6}{256l_p^2 c^4} \cdot \frac{1}{c} = \alpha \quad (74)$$

$$\alpha = 2(8\pi^4 \Omega^4) / \left( \frac{\alpha}{2^{11} \pi^5 \Omega^4} \right) \left( \frac{128\pi^4 \Omega^3}{\alpha} \right)^2 (2\pi \Omega^2) = \alpha \quad (75)$$

$$\text{units} = \frac{u^{19}}{u^{56}(u^{-27})^2 u^{17}} = 1 \quad (76)$$

4.5. I have also premised a 2nd mathematical constant which I have denoted Omega. We can find a numerical solution using the precise  $c^*, \mu_0^*, R^*$ ;

$$\Omega = 2.0071349496...$$

$$\frac{(c^*)^{35}}{(\mu_0^*)^9 (R^*)^7}, \text{ units} = \frac{(u^{17})^{35}}{(u^{56})^9 (u^{13})^7} = 1 \quad (77)$$

$$\frac{(c^*)^{35}}{(\mu_0^*)^9 (R^*)^7} = (2\pi \Omega^2)^{35} / \left( \frac{\alpha}{2^{11} \pi^5 \Omega^4} \right)^9 \cdot \left( \frac{1}{2^{23} 3^3 \pi^{11} \alpha^5 \Omega^{17}} \right)^7 \quad (78)$$

$$\Omega^{225} = \frac{(c^*)^{35}}{2^{295} 3^{21} \pi^{157} (\mu_0^*)^9 (R^*)^7 \alpha^{26}}, \text{ units} = 1 \quad (79)$$

There is a close sqrt natural number solution for  $\Omega$ ;

$$\Omega = \sqrt{\left( \frac{\pi^e}{e^{(e-1)}} \right)} = 2.0071 \ 349 \ 5432... \quad (80)$$

4.6.  $\Omega^{(15)^n}$  apparently has a 'buffer' role. As constants of the series  $u^{15}, u^{30}, ..., u^{90}$  have no  $\Omega$ , this suggests a base structure. For example;

$$\beta = \frac{\Omega}{a^{1/3}} = \frac{\Omega v}{r^2} = \frac{\Omega}{t^{2/15} k^{1/5}} \dots, \text{ unit} = u \quad (81)$$

Using M and  $\beta$  (see 4.2);

$$M = \frac{r^4}{v}, u^{15} \text{ (kg)} \quad (82)$$

$$P = M\beta = \Omega r^2, u^{16} \text{ (q)} \quad (83)$$

$$V = 2\pi M\beta^2 = 2\pi \Omega^2 v, u^{17} \text{ (m/s)} \quad (84)$$

$$T^2 = (2\pi \Omega)^{15} \frac{P^9}{2\pi V^{12}} = (2\pi \frac{r^9}{v^6})^2, u^{-60} \text{ (s}^2\text{)} \quad (85)$$

Using only  $\beta$  we find this unit-less ratio  $r^{17}/v^8$  that maintains the numerical values of the dimensionful constants within a boundary, in SI units  $r^{17}/v^8 = 0.813 \times 10^{-59}$  (see 4.3);

$$A = \beta^3 \left( \frac{2^6 \pi^3}{\alpha} \right) = \frac{2^6 \pi^3 \Omega^3 v^3}{\alpha r^6}, u^3 \text{ (a)} \quad (86)$$

$$R = \beta^8 \left( \frac{r^{17}}{v^8} \right) = \Omega^8 r, u^8 \quad (87)$$

$$L^{-1} = \beta^{13} \frac{1}{(2\pi^2 \Omega^{15})} \left( \frac{r^{17}}{v^8} \right) = \frac{1}{2\pi^2 \Omega^2} \frac{v^5}{r^9}, u^{13} \text{ (1/m)} \quad (88)$$

$$M = \beta^{15} \left( \frac{1}{\Omega^{15}} \right) \left( \frac{r^{17}}{v^8} \right)^2 = \frac{r^4}{v}, u^{15} \text{ (kg)} \quad (89)$$

$$P = \beta^{16} \left( \frac{1}{\Omega^{15}} \right) \left( \frac{r^{17}}{v^8} \right)^2 = \Omega r^2, u^{16} \text{ (q)} \quad (90)$$

$$V = \beta^{17} \left( \frac{2\pi}{\Omega^{15}} \right) \left( \frac{r^{17}}{v^8} \right)^2 = 2\pi \Omega^2 v, u^{17} \text{ (m/s)} \quad (91)$$

$$T^{-1} = \beta^{30} \left( \frac{1}{2\pi \Omega^{30}} \right) \left( \frac{r^{17}}{v^8} \right)^3 = \frac{1}{2\pi} \frac{v^6}{r^9}, u^{30} \text{ (1/s)} \quad (92)$$

$$\mu_0^* = \beta^{56} \left( \frac{\alpha}{2^{11} \pi^5 \Omega^{60}} \right) \left( \frac{r^{17}}{v^8} \right)^7 = \frac{\alpha}{2^{11} \pi^5 \Omega^4} r^7, u^{56} \quad (93)$$

$$\epsilon_0^{*-1} = \beta^{90} \left( \frac{\alpha}{2^9 \pi^3 \Omega^{90}} \right) \left( \frac{r^{17}}{v^8} \right)^{11} = \frac{\alpha}{2^9 \pi^3} v^2 r^7, u^{90} \quad (94)$$

4.7. Unit = 1 combinations (examples)

$$\left( \frac{r^{17}}{v^8} \right) = \frac{u^{8*17}}{u^{17*8}} = (k^2 t = \frac{u^{15*2}}{u^{30}}), \text{ units} = 1 \quad (95)$$

$$M^2 = \frac{r^8}{v^2}, \text{ unit} = u^{8*8-17*2=30} \text{ (kg}^2\text{)} \quad (96)$$

$$T^{-1} = \frac{v^6}{2\pi r^9}, \text{ unit} = u^{17*6-8*9=30} \text{ (1/s)} \quad (97)$$

$$M^2 T = \frac{r^8}{v^2} \frac{2\pi r^9}{v^6} = 2\pi \left( \frac{r^{17}}{v^8} \right), \text{ unit} = 1 \quad (98)$$

4.8. We can numerically solve the physical constants by replacing the mathematical  $(c^*, \mu_0^*, R^*)$  with the CODATA mean values for  $(c, \mu_0, R)$  as in section 3.8.

$$h^* = 2^3 \pi^4 \Omega^4 \frac{r^{13}}{v^5}, u^{19} \quad (99)$$

We then find there is a combination of  $(c^*, \mu_0^*, R^*)$  which reduces to  $h^3$ .

$$(h^*)^3 = \frac{2\pi^{10} (\mu_0^*)^3}{3^6 (c^*)^5 \alpha^{13} (R^*)^2}, \text{ unit} = u^{57} \quad (100)$$

Likewise with the other dimensionful constants, we note that these equations are equivalent to section 3.8;

$$(e^*)^3 = \frac{4\pi^5}{3^3 (c^*)^4 \alpha^8 (R^*)}, \text{ unit} = u^{-81} \quad (101)$$

$$(k_B^*)^3 = \frac{\pi^5(\mu_0^*)^3}{3^3 2(c^*)^4 \alpha^5 (R^*)^2}, \text{ unit} = u^{87} \quad (102)$$

$$(G^*)^5 = \frac{\pi^3(\mu_0^*)}{2^{20} 3^6 \alpha^{11} (R^*)^2}, \text{ unit} = u^{30} \quad (103)$$

$$(m_e^*)^3 = \frac{16\pi^{10}(R^*)(\mu_0^*)^3}{3^6 (c^*)^8 \alpha^7}, \text{ unit} = u^{45} \quad (104)$$

$$(r_d)^3 = \frac{3^3 4\pi^5(\mu_0^*)^3 \alpha^{19} (R^*)^2}{5^3 (c^*)^{10}}, \text{ unit} = u^{24} \quad (105)$$

## 5 Virtual universe

The electron formula  $f_e$  can be constructed from ampere-meters AL and time T and yet it is a dimensionless (mathematical) constant;

$$f_e = (AL)^3/T = 0.239 \times 10^{23}, \text{ units} = 1$$

This formula has 3 space dimensions  $L^3$  and 1 time dimension  $T$ . We could then speculate that if the vacuum of our 3-D space is electro-magnetic in nature such that it is also a construct of ampere-meters  $(AL)^3$  instead of an empty void measured in meters, then the sum universe may also be a dimensionless (mathematical) constant (aka a virtual universe);

$$f_{\text{universe}} = X(AL)^3/T, \text{ units} = 1$$

## 6 Notes

In 1963, Dirac noted regarding the fundamental constants; "The physics of the future, of course, cannot have the three quantities  $\hbar, e, c$  all as fundamental quantities. Only two of them can be fundamental, and the third must be derived from those two." [25]

In the article "Surprises in numerical expressions of physical constants", Amir et al write ... In science, as in life, 'surprises' can be adequately appreciated only in the presence of a null model, what we expect a priori. In physics, theories sometimes express the values of dimensionless physical constants as combinations of mathematical constants like pi or e. The inverse problem also arises, whereby the measured value of a physical constant admits a 'surprisingly' simple approximation in terms of well-known mathematical constants. Can we estimate the probability for this to be a mere coincidence? [24]

J. Barrow and J. Webb on the fundamental constants; 'Some things never change. Physicists call them the *constants of nature*. Such quantities as the velocity of light,  $c$ , Newton's constant of gravitation,  $G$ , and the mass of the electron,  $m_e$ , are assumed to be the same at all places and times in the universe. They form the scaffolding around which theories of physics are erected, and they define the fabric of our universe. Physics has progressed by making ever more accurate measurements of their values. And yet, remarkably, no

one has ever successfully predicted or explained any of the constants. Physicists have no idea why they take the special numerical values that they do. In SI units,  $c$  is 299,792,458;  $G$  is 6.673e-11; and  $m_e$  is 9.10938188e-31 -numbers that follow no discernible pattern. The only thread running through the values is that if many of them were even slightly different, complex atomic structures such as living beings would not be possible. The desire to explain the constants has been one of the driving forces behind efforts to develop a complete unified description of nature, or "theory of everything". Physicists have hoped that such a theory would show that each of the constants of nature could have only one logically possible value. It would reveal an underlying order to the seeming arbitrariness of nature.' [6].

At present, there is no candidate theory of everything that is able to calculate the mass of the electron [23].

"There are two kinds of fundamental constants of Nature: dimensionless (alpha) and dimensionful (c, h, G). To clarify the discussion I suggest to refer to the former as fundamental parameters and the latter as fundamental (or basic) units. It is necessary and sufficient to have three basic units in order to reproduce in an experimentally meaningful way the dimensions of all physical quantities. Theoretical equations describing the physical world deal with dimensionless quantities and their solutions depend on dimensionless fundamental parameters. But experiments, from which these theories are extracted and by which they could be tested, involve measurements, i.e. comparisons with standard dimensionful scales. Without standard dimensionful units and hence without certain conventions physics is unthinkable" -*Triologue* [5].

"The fundamental constants divide into two categories, units independent and units dependent, because only the constants in the former category have values that are not determined by the human convention of units and so are true fundamental constants in the sense that they are inherent properties of our universe. In comparison, constants in the latter category are not fundamental constants in the sense that their particular values are determined by the human convention of units" -*L. and J. Hsu* [4].

A charged rotating black hole is a black hole that possesses angular momentum and charge. In particular, it rotates about one of its axes of symmetry. In physics, there is a speculative notion that if there were a black hole with the same mass and charge as an electron, it would share many of the properties of the electron including the magnetic moment and Compton wavelength. This idea is substantiated within a series of papers published by Albert Einstein between 1927 and 1949. In them, he showed that if elementary particles were treated as singularities in spacetime, it was unnecessary to postulate geodesic motion as part of general relativity [14].

The Dirac Kerr–Newman black-hole electron was introduced by Burinskii using geometrical arguments. The Dirac wave function plays the role of an order parameter that signals a broken symmetry and the electron acquires an extended space-time structure. Although speculative, this idea was corroborated by a detailed analysis and calculation [8].

Max Tegmark’s Mathematical Universe Hypothesis: Our external physical reality is a mathematical structure. That is, the physical universe is mathematics in a well-defined sense, and “in those [worlds] complex enough to contain self-aware substructures [they] will subjectively perceive themselves as existing in a physically ‘real’ world” [10].

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