the black-hole electron
a mathematical universe hypothesis

In the "Trialogue on the number of fundamental physical constants", Okun, Veneziano and M. Duff debated the number, from 1 to 3, of dimensionful units required. In this essay I describe a mathematical model whereby the dimensioned physical constants G, h, e, c, m_e, k_B are defined by geometrical forms constructed from 2 dimensionless constants; the Sommerfeld fine structure constant α and a proposed Ω, and by 2 scalable dimensionful (Planck) units. By simply assigning the appropriate numerical values to the 2 scalars we may solve the physical constants for any system of units, whether human or non-terrestrial. A dual-state electron is proposed that periodically oscillates between a dimensionful magnetic monopole (σ_e, AL units = $s^{-1/3}$) 'wave-state' that when combined with Planck time (T, units = s), collapses into a (Tσ_e^3, units = s/s = 1), dimensionless (black-hole) 'point-state' suggesting a Planck-unit theory where this periodicity dictates the frequency of the Planck units, thus E = $hv = mc^2$. The dimensionless geometries for mass M=1, time T=2π, velocity V=$2\pi\Omega^2$, length L=$2\pi^2\Omega^2$ suggest that an angular motion (rotation) may be the means by which dimensionality is conferred upon the dimensionless electron, a key condition for a mathematical universe hypothesis. The gravitational coupling constant formula suggests that gravity is an interaction between the dimensionless point-states, if so then gravity has a magnitude consistent with the strong force. The square root of Planck momentum is used to link the charge constants with the mass constants, this then permits us to define our SI G, h, e, m_e, k_B values in terms of the 4 most accurate SI constants; c, μ_0 (exact values), fine structure constant alpha (11-12 digits precision) and the Rydberg constant (12-13 digits precision), results are consistent with CODATA 2014.

	Calculated (R, c, μ_0, α) [10]	CODATA 2014
speed of light	(299792458)	c = 299792458 (exact)
Fine structure constant	(137.035999139)	α = 137.035 999 139(31) [15]
Rydberg constant	(10973731.568508)	R_∞ = 10 973 731.568 508(65) [13]
Planck constant	h^* = .662 606 913 413 e-33	h = .662 607 004 0(81) e-33 [14]
Elementary charge	e^* = .160 217 651 130 e-18	e = .160 217 662 08(98) e-18 [16]
Vacuum permeability	$(4\pi/10^7)$	$\mu_0 = 4\pi/10^7$, (exact) [18]
Electron mass	m_e^* = .910 938 231 256 e-30	m_e = .910 938 356(11) e-30 [17]
Boltzmann's constant	k_B^* = .137 951 014 752 e-22	k_B = .138 064 852(79) e-22 [20]
Larmor frequency	f_L = 28 024.953 551	f_L = 28 024.951 64(17) [22]
Gravitation constant	G^* = .667 249 719 229 e-10	G = .667 408(31) e-10 [19]
Von Klitzing constant	R_K^* = 25 812.807 455 591	R_K = 25 812.807 455 5(59) [21]
Bohr magneton	μ_B^* = .927 400 936 03e-23	μ_B = .927 400 999 (57)e-26 [23]

keywords: Mathematical Universe Hypothesis, fundamental physical constants, fine structure constant alpha, Omega, black-hole electron, wave-particle duality, Dirac-Kerr–Newman electron, Planck unit theory;

1. *Background*

Mathematical realism holds that mathematical entities exist independently of the human mind. Thus humans do not invent mathematics, but rather discover it, and any other intelligent beings in the universe would presumably do the same. In physics and cosmology, the mathematical universe hypothesis (MUH), also known as the Ultimate Ensemble, is a speculative "theory of everything" (TOE) proposed by the cosmologist Max Tegmark [12].

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 [11].

The Dirac–Kerr–Newman (black-hole) electron was introduced by Burinskii by 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 [5].

Wave–particle duality is the concept that every elementary particle or quantic entity may be partly described in terms not only of particles, but also of waves. It expresses the inability of the classical concepts "particle" or "wave" to fully describe the behavior of quantum-scale objects.

J. Barrow and J Webb in their 2005 Scientific American article on the fundamental constants wrote;

'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 the 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.' [3]

Planck units are a set of natural units of measurement defined exclusively in terms of five universal physical constants, in such a manner that these five physical constants take on the numerical value of $G = hbar = c = 1/4\pi\epsilon_0 = k_B = 1$ when expressed in terms of these units. Originally proposed in 1899 by German physicist Max Planck, these units are also known as natural units because the origin of their definition comes only from properties of nature and not from any human construct.

"we get the possibility to establish units for length, mass, time and temperature which, being independent of specific bodies or substances, retain their meaning for all times and all cultures, even non-terrestrial and non-human ones and could therefore serve as natural units of measurements..."
-Max Planck [12].

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 -*Trialogue* [2].

L. and J. Hsu have argued that the fundamental constants divide into two categories, units-independent (*category A*), and units-dependent (*category B*), because only 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 [1].

2. *Generic system of units*

In this essay I describe a mathematical model in which the dimensioned physical constants G, h, c, e, m_e, k_B... can be divided into 2 parts; 2.1) a category A component being a geometrical form constructed from 2 dimensionless constants and 2.2) a category B which is the dimensionful component constructed according to 2 scalable (Planck) units, such that the formulas for the physical constants are rendered independent of human or alien convention yet at the same time can be scaled and solved for any chosen system of units.

physical constant = (category A) x (category B)

A formula for an electron is also proposed, combining dimensionful magnetic monopoles and (Planck) time but in such a ratio that periodically the category B (dimensionful units) cancel (category B = 1) leaving this electron as a dimensionless geometrical 'entity' which arguably suggests a micro black-hole and thus defining a black-hole electron.

The dimensionful magnetic monopole state I have labeled as the (electric) wave-state.

The duration of the dimensionless state defines or is defined by 1 unit of Planck time and is labeled as the (mass) point-state.

The formula that determines the period of 1 oscillation cycle is defined as the dimensionless electron function f_e. The electron thus oscillates between a dimensionful electric wave-state and a dimensionless point-state.

As the units cancel, this formula for electron periodicity is also a dimensionless constant and so independent of the system of units despite being a construct of dimensionful units.

2.1. *Category A (dimensionless geometries)*:

In this category the constants are each characterized by a dimensionless geometrical form. To construct these geometries I use 2 constants; 1 is the (inverse) fine structure constant alpha and the 2nd a number which for convenience I have denoted Omega.

Richard Feynman referred to the fine-structure constant in these terms:

There is a most profound and beautiful question associated with the observed coupling constant... It has been a mystery ever since it was discovered more than fifty years ago, and all good theoretical physicists put this number up on their wall and worry about it. Immediately you would like to know where this number for a coupling comes from: is it related to pi or perhaps to the base of natural logarithms e? Nobody knows. It's one of the greatest damn mysteries of physics: a magic number that comes to us with no understanding by man. You might say the "hand of God" wrote that number, and "we don't know how He pushed his pencil." ... [9]

The CODATA 2014 mean value for $\alpha = 137.035999139$ gives a best fit Omega as $\Omega \sim 2.00713494963$.

I note that if we set $\alpha = 137.035996368$ then we may derive the following natural number solution for Omega in terms solely of π and e eq(1). This particular solution is not required by this model, however I note it here partly for its geometrical simplicity but more principally that it is a square root solution and we find this recurring throughout this model such that in all charge related formulas Omega occurs only in the form Ω^3 and Ω^5 and in mass related formulas as Ω^2. In the context of this model, this consistency arguably deserves consideration.

$$\Omega = \sqrt{\left(\frac{\pi^e}{e^{(e-1)}}\right)} = 2.0071349543249... \tag{1}$$

3 (category A) dimensionless geometries MTP;

$$M = 1 \tag{2}$$

$$T = 2\pi \tag{3}$$

$$P = \Omega \tag{4}$$

Can be used to define LVA;

$$V = \frac{2\pi P^2}{M} = 2\pi\Omega^2 \tag{5}$$

$$2L = TV = 4\pi^2\Omega^2 \tag{6}$$

$$A = \frac{8V^3}{\alpha P^3} = \frac{64\pi^3\Omega^3}{\alpha} \tag{7}$$

I defined VLA in terms of MTP, this was for convenience as other combinations can equally be used.

2.2. *Category B (dimensionful units)*:

To add dimensionality to the physical constants requires 2 units. I have labeled the basic units; m as a mass unit, l as a length unit, t as a time unit, v as a velocity unit, a as a charge unit, p as a sqrt of momentum unit. We can use these units to add dimensionality to their corresponding dimensionless geometries thus forming Planck unit equivalents;

$$M = (1)m, \ (mass) \tag{8}$$

$$T = (2\pi)t, \ (time) \tag{9}$$

$$P = (\Omega)p, \ (sqrt\ of\ momentum) \tag{10}$$

$$V = (2\pi\Omega^2)v, \ (velocity) \tag{11}$$

$$L = (2\pi^2\Omega^2)l, \ (length) \tag{12}$$

$$A = \left(\frac{64\pi^3\Omega^3}{\alpha}\right)a^3, \ (ampere) \tag{13}$$

In section 5.5 on the 'electron as a magnetic monopole', I define the electron using ampere-meters (AL), as these are the units for a magnetic monopole σ_e eq(30), but when we measure these in units of Planck time (T) our dimensionful (t, l, a) units overlap and cancel each other leaving the electron as a dimensionless constant whose formula f_e eq(14) resembles torus volume or hyper-sphere surface; $4\pi^2 r^3$.

$$f_e^{-1} = \frac{\sigma_e^3}{T} = 4\pi^2(2^6 3\pi^2\alpha\Omega^5)^3, \ units = \frac{(a^3 l)^3}{t} = \frac{s}{s} = 1 \tag{14}$$

This can be rationalized if the electron is periodically oscillating between a dimensionful magnetic monopole state which after 1 complete rotation T=2π eq(3), collapses into a dimensionless geometrical form before emerging back into the dimensionful state.

The units of dimensionality for the electron are (t, l, a) but as these units are also interchangeable with (m, p, v) we can use any of the following equivalent ratios suggesting that the dimensionful units are also not independent but reflect an underlying geometry.

$$f_e\ units;\ \frac{(a^3 l)^3}{t} = \frac{l^{15}}{m^9 t^{11}} = \frac{p^{15} t^2}{m^{12}} = \frac{v^{12} t^2}{p^9} = 1 \tag{15}$$

As such, we may for example define l in terms of m, t

$$\frac{l^{15}}{m^9 t^{11}} = \frac{(m^{3/5} t^{11/15})^{15}}{(m)^9 (t)^{11}} = m^0 t^0 = 1 \tag{16}$$

$$length\ l = m^{3/5} t^{11/15} \tag{17}$$

By this means we may reduce the number of required dimensionful units to 2.

2.3. *Physical constants (generic formulas)*

In the following example I define the physical constants using for the 2 required units (a, l). In sections 6.1 and 6.2 I give equivalent solutions using (m, t) and (p, v). The physical constants are written according to the format: physical constant = (dimensionless) x (dimensionful):

physical constant = $(\alpha^i \Omega^j)$ x $(a^m l^n)$

Setting AL in terms of (α, Ω) and (a, l) eq(12, 13);

$$A = \left(\frac{64\pi^3\Omega^3}{\alpha}\right) a^3,\ (ampere) \tag{18}$$

$$L = (2\pi^2\Omega^2)\ l,\ (length) \tag{19}$$

We can now derive MTV in terms of AL;

$$T = (2\pi)\ l^3 a^9,\ (time) \tag{20}$$

$$V = \frac{2L}{T} = (2\pi\Omega^2)\ \frac{1}{l^2 a^9},\ (velocity) \tag{21}$$

$$M = \frac{8\pi V}{\alpha^{2/3} A^{2/3}} = (1)\frac{1}{l^2 a^{11}},\ (mass) \tag{22}$$

Generic forms of G, h, e, m_e, k_B... in terms of AL;

$$G^* = \frac{V^2 L}{M} = (8\pi^4\Omega^6)\ \frac{1}{la^7} \tag{23}$$

$$T_P^* = \frac{AV}{\pi} = \left(\frac{128\pi^3\Omega^5}{\alpha}\right)\ \frac{1}{l^2 a^6} \tag{24}$$

$$\mu_0^* = \frac{\pi V^2 M}{\alpha L A^2} = \left(\frac{\alpha}{2048\pi^5\Omega^4}\right)\ \frac{1}{l^7 a^{35}} \tag{25}$$

$$e^* = AT = \left(\frac{128\pi^4\Omega^3}{\alpha}\right)\ l^3 a^{12} \tag{26}$$

$$h^* = 2\pi LVM = (8\pi^4\Omega^4)\ \frac{1}{l^3 a^{20}} \tag{27}$$

$$k_B^* = \frac{\pi VM}{A} = \left(\frac{\alpha}{32\pi\Omega}\right)\ \frac{1}{l^4 a^{23}} \tag{28}$$

$$\epsilon_0^* = \frac{\alpha A^2 L}{\pi V^4 M} = \left(\frac{2^9\pi^3}{\alpha}\right)\ l^{11} a^{53} \tag{29}$$

$$\sigma_e = \frac{3\alpha^2 AL}{\pi^2}\ la^3 \tag{30}$$

$$f_e^{-1} = \frac{\sigma_e^3}{T} = 4\pi^2(2^6 3\pi^2\alpha\Omega^5)^3\ l^0 a^0 \tag{31}$$

$$m_e^* = M(f_e) \tag{32}$$

$$\lambda_e^* = \left(\frac{2\pi}{f_e}\right) L \tag{33}$$

$$\alpha_G^* = f_e^2 \tag{34}$$

$$R^* = \left(\frac{m_e}{4\pi l_p \alpha^2 m_P}\right) = \frac{M(f_e)}{4\pi L\alpha^2 M} = \frac{f_e}{(2\pi\alpha)^2 L} \tag{35}$$

Note that the mass and wavelength of the electron are the frequencies of Planck mass eq(32) and Planck length eq(33) respectively suggesting that electron mass measures the average frequency of occurrence of units of Planck mass M = 1 (the average frequency of occurrence of the dimensionless point-state) per second and as wavelength is a function of the dimensionful (magnetic monopole) wave-state; the formulas $E = hv$ and $E = mc^2$ are both measures of this oscillation.

$E = mc^2$ measures the frequency of the point-state, $E = hv$ measures the frequency of the wave-state and as there is 1 wave-state for every 1 point-state $E = E$.

The gravitational coupling constant a_G eq(34) can be interpreted as the probability of any 2 electrons being in the dimensionless point-state simultaneously for any chosen unit of Planck time, the electron point-state may thereby be associated with gravity and so also mass.

3. *SI Units*

To solve the above formulas in terms of SI units, we need to scale (a, l) to the appropriate numerical values. The dimensionless (category A) component remains unchanged, it is galaxy-independent.

Setting (a, l) to numerical values (a_{SI}, l_{SI}) for an SI Planck ampere eq(18) and Planck length eq(19) permits us to solve the SI physical constants (section 2 formulas), results are consistent with CODATA 2014 (see table p.1).

a_{SI} = 23326078.8267a (best fit)
l_{SI} = .203220881958e-36m (best fit)
α = 137.035999139 (CODATA 2014 mean)
Ω = 2.00713494963 (best fit)

4. *Analysis*

We can now test the theory behind our model. The values of the Planck ampere and Planck length are known to a low precision and so the above (a_{SI}, l_{SI}, Ω) were chosen as best fit values and not from experiment. What we can do is re-write these formulas in terms of known physical constants.

4.1. *Dimensionful ratios*

We can redefine the formulas given in section 2 in terms of the 4 most accurate constants; c, μ_0 (exact value), the Rydberg R (12-13 digits) and α. In the SI system of units this would not be correct.

We first replace the SI units for (c, μ_0, R) with their corresponding (a, l) units and then determine which ratios of (c, μ_0, R) will give the same ratio of (a, l) as for each constant respectively. We can then numerically solve the constants using the R and α CODATA 2014 values (c, μ_0 have fixed values). In section 6 I show how we may also do this using (m, t) and (v, p) in place of (a, l);

R = 10973731.568508 (CODATA 2014 mean)
α = 137.035999139 (CODATA 2014 mean)

The (a, l) units and corresponding SI units for (c, μ_0, R);

$$V = c,\ units = \frac{1}{l^2 a^9},\ \left(\frac{m}{s}\right) \tag{36}$$

$$\mu_0,\ units = \frac{1}{l^7 a^{35}},\ \left(\frac{kg.m}{s^2 A^2}\right) \tag{37}$$

$$R,\ units = \frac{1}{l},\ \left(\frac{1}{m}\right) \tag{38}$$

Formulas for the constants in terms of (c, μ_0, R);
Planck constant (eq.27)
h = .662 606 913 413 e-33 (see table p1)

$$h^3 = \frac{2\pi^{10}\mu_0^3}{3^6c^5\alpha^{13}R^2},\ units = \frac{1}{l^9a^{60}} \tag{39}$$

$$i.e.:\ \frac{2\pi^{10}\mu_0^{*3}}{3^6c^{*5}\alpha^{13}R^{*2}} = (\frac{8\pi^4\Omega^4}{l_{SI}^3a_{SI}^{20}})^3 = h^3 \tag{40}$$

Elementary charge (eq.26)
e = .160 217 651 130 e-18

$$e^3 = \frac{4\pi^5}{3^3c^4\alpha^8R},\ units = l^9a^{36} \tag{41}$$

Boltzmann constant (eq.28)
k_B = .137 951 014 752 e-22

$$k_B^3 = \frac{\pi^5\mu_0^3}{3^32c^4\alpha^5R},\ units = \frac{1}{l^{12}a^{69}} \tag{42}$$

Gravitation constant (eq.23)
G = .667 249 719 229 e-10

$$G^5 = \frac{\pi^3\mu_0}{2^{20}3^6\alpha^{11}R^2},\ units = \frac{1}{l^5a^{35}} \tag{43}$$

Electron mass (eq.32)
m_e^* = .910 938 231 256 e-30

$$m_e^3 = \frac{16\pi^{10}R\mu_0^3}{3^6c^8\alpha^7},\ units = \frac{1}{l^6a^{33}} \tag{44}$$

Planck time (eq.20)

$$t_p^{15} = \frac{\pi^{22}\mu_0^9}{2^{20}3^{24}c^{50}\alpha^{49}R^8}, units = l^{45}a^{135} \tag{45}$$

Planck mass (eq.22)

$$m_P^{15} = \frac{2^{25}\pi^{13}\mu_0^6}{3^6c^5\alpha^{16}R^2},\ units = \frac{1}{l^{30}a^{165}} \tag{46}$$

4.2. *Dimensionless ratios*
Selecting a ratio whereby units for $c, \mu_0, R = 1$ gives f_e^{15};

$$\frac{c^{35}}{\mu_0^9R^7} = \frac{\pi^{37}}{2^53^{24}\alpha^{19}f_e^{15}}l^0a^0,\ units = 1 \tag{47}$$

The ratios given in eq(15) are dimensionless. Therefore if we replace these units with their equivalent (Planck) units we should find that the numerical solutions are fixed (galaxy-independent) as noted in eq(16, 17) given that they have now become category A (dimensionless) ratios. In the following we simply replace MLTPV with the SI Planck unit equivalents, this means that for example if we know the numerical values for Planck mass and Planck time then we can numerically solve Planck length and so forth (for Q refer section 5).

$$\frac{L^{15}}{M^9T^{11}} = \frac{l_p^{15}}{m_P^9t_p^{11}} = 16\pi^{19}\Omega^{30} \tag{48}$$

$$\frac{T^2V^{12}}{P^9} = \frac{t_p^2c^{12}}{Q^9} = (2\pi\Omega)^{14}\Omega \tag{49}$$

$$\frac{P^{15}T^2}{M^{12}} = \frac{Q^{15}t_p^2}{m_P^{12}} = 4\pi^2\Omega^{15} \tag{50}$$

4.3. *Scaling*
In order to convert from the base units *mltvpa* to their SI Planck unit equivalents, I assigned numerical scalar values to a and l such that Planck length l_p for example becomes;
$L_{SI} = l_p = (2\pi^2\Omega^2)l_{SI}$
where l_{SI} is the unit of length l but measured in terms of the SI unit 'meter'. The Bohr radius for example would then become;

$$r_{Bohr} = \alpha n^2\lambda_e = \frac{\alpha n^2 l_p}{f_e} = \frac{\alpha n^2 2\pi^2\Omega^2 l_{SI}}{f_e} = \frac{\alpha}{f_e}.2\pi^2(n\Omega)^2 l_{SI} \tag{51}$$

Likewise if we meet a non-terrestrial civilization, we need only determine 2 of their Planck units in order to solve their values for G, h, c, e, m_e, k_B... using their system of units where
$L_{alien} = (2\pi^2\Omega^2)l_{alien}$
$T_{alien} = (2\pi)t_{alien}$...

The dimensionless components (category A) are galaxy independent, the dimensionful units (category B) are scaled accordingly.

For aliens living on a black hole we may presume default values for the units $m_{bh} = t_{bh} = l_{bh}... = 1$

5. *Sqrt of Planck momentum*
I have premised that the sqrt of momentum P is a link between mass and charge. To rationalize this premise I use for momentum the SI Planck momentum and show how this can be used to derive the formulas listed in sections 2, 3 [10].

Denoting the sqrt of Planck momentum with the letter Q ($P_{SI} = Q$) such that;
Planck momentum = $2\pi Q^2$, units = (kg.m/s)

$$Q = 1.019\ 113...\ units = \sqrt{\frac{kg.m}{s}} \tag{52}$$

5.1. The mass constants in terms of Q^2, c, l_p;

$$m_P = \frac{2\pi Q^2}{c} \tag{53}$$

$$G = \frac{l_pc^3}{2\pi Q^2} \tag{54}$$

$$h = 2\pi Q^2 2\pi l_p \tag{55}$$

$$t_p = \frac{2l_p}{c} \tag{56}$$

$$F_p = \frac{E_p}{l_p} = \frac{2\pi Q^2}{t_p} \tag{57}$$

5.2. The charge constants in terms of Q^3, c, α, l_p;

$$A_Q = \frac{8c^3}{\alpha Q^3} \tag{58}$$

$$e = AT = \frac{8c^3}{\alpha Q^3}.\frac{2l_p}{c} = \frac{16 l_p c^2}{\alpha Q^3} \tag{59}$$

$$T_p = \frac{AV}{\pi} = \frac{8c^3}{\alpha Q^3}.\frac{c}{\pi} = \frac{8c^4}{\pi\alpha Q^3} \tag{60}$$

$$k_B = \frac{E_p}{T_p} = \frac{\pi^2 \alpha Q^5}{4c^3} \tag{61}$$

5.3. 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.

$$\frac{F_{electric}}{A_Q^2} = \frac{2\pi Q^2}{\alpha t_p}.(\frac{\alpha Q^3}{8c^3})^2 = \frac{\pi\alpha Q^8}{64 l_p c^5} = \frac{2}{10^7} \tag{62}$$

$$\mu_0 = \frac{\pi^2 \alpha Q^8}{32 l_p c^5} = \frac{4\pi}{10^7} \tag{63}$$

5.4. Planck length l_p in terms of Q, c, α, μ_0;

$$l_p = \frac{\pi^2 \alpha Q^8}{32 \mu_0 c^5} \tag{64}$$

$$\mu_0 = 4\pi.10^{-7}$$

$$l_p = \frac{5^7 \pi\alpha Q^8}{c^5} \tag{65}$$

Replacing Planck length with eq(65) gives;

$$h = 2\pi Q^2 2\pi l_p = \frac{2^2 5^7 \pi^3 \alpha Q^{10}}{c^5} \tag{66}$$

$$e = \frac{16 l_p c^2}{\alpha Q^3} = \frac{2^4 5^7 \pi Q^5}{c^3} \tag{67}$$

$$G = \frac{l_p c^3}{2\pi Q^2} = \frac{5^7 \alpha Q^6}{2c^2} \tag{68}$$

Von Klitzing constant in terms of c, α;

$$R_K = \frac{h}{e^2} = \frac{\pi\alpha c}{5000000} \tag{69}$$

5.5. A magnetic monopole in terms of Q, c, α, 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 σ_e is a hypothetical particle that is a magnet with only 1 pole [8]. A proposed monopole σ_e [7].

$$\sigma_e = \frac{2\pi^2}{3\alpha^2 ec} \tag{70}$$

The electron frequency component f_e;

$$f_e = t_p \sigma_e^3 = \frac{\pi^6 Q^9}{2^8 3^3 \alpha^3 l_p^2 c^{10}} \tag{71}$$

Electron mass:

$$m_e = m_P f_e \tag{72}$$

Electron wavelength:

$$\lambda_e = \frac{2\pi l_p}{f_e} \tag{73}$$

Gravitation coupling constant:

$$\alpha_G = (\frac{m_e}{m_P})^2 = f_e^2 \tag{74}$$

Magnetic Induction

$$B_e = \frac{m_P}{\alpha^2 A_Q t_p^2} f_e^2 \tag{75}$$

5.6. Rydberg constant R_∞

$$R_\infty = \frac{m_e e^4 \mu_0^2 c^3}{8h^3} = \frac{2^5 c^5 \mu_0^3}{3^3 \pi \alpha^8 Q^{15}} \tag{76}$$

The Rydberg constant $R_\infty = 10973731.568508(65)$ [13] with a 12-13 digit precision is the most accurate of the natural constants. The known precision of Planck momentum and so Q is low, however with the solution for the Rydberg constant eq(76) we may now rationalize Q (and l_p) in terms of the 4 most accurate constants, c (exact value), μ_0 (exact value), R and alpha (see formulas listed in section 2), whereby;

$$Q^{15} = \frac{2^5 c^5 \mu_0^3}{3^3 \pi \alpha^8 R} \tag{77}$$

$$l_p = \frac{\pi^2 \alpha Q^8}{32 \mu_0 c^5} \tag{78}$$

for example;

$$e = \frac{16 l_p c^2}{\alpha Q^3} = \frac{\pi^2 Q^5}{2\mu_0 c^3} \tag{79}$$

$$e^3 = \frac{\pi^6 Q^{15}}{8 \mu_0^3 c^9} = \frac{4\pi^5}{3^3 c^4 \alpha^8 R} \tag{80}$$

6. *Appendix*

6.1. Constants in terms of mass and time m, t

m_{SI} = .217672817580...e-7 kg;

t_{SI} = .171585512841...e-43 s;

$M = (1)m, \ (mass)$
$T = (2\pi)t, \ (time)$

$$P = (\Omega)\ \frac{m^{4/5}}{t^{2/15}},\ (sqrt\ of\ momentum) \tag{81}$$

$$V = \frac{2\pi P^2}{M} = (2\pi\Omega^2)\ \frac{m^{3/5}}{t^{4/15}},\ (velocity) \tag{82}$$

$$L = \frac{TV}{2} = (2\pi^2\Omega^2)\ m^{3/5}t^{11/15},\ (length) \tag{83}$$

$$A = \frac{8V^3}{\alpha P^3} = \left(\frac{64\pi^3\Omega^3}{\alpha}\right)\ \frac{1}{m^{3/5}t^{2/5}},\ (ampere) \tag{84}$$

$$G^* = \frac{V^2L}{M} = (8\pi^4\Omega^6)\ m^{4/5}t^{1/5} \tag{85}$$

$$T_P^* = \frac{AV}{\pi} = \left(\frac{128\pi^3\Omega^5}{\alpha}\right)\ \frac{1}{t^{2/3}} \tag{86}$$

$$\mu_0^* = \frac{\pi V^2 M}{\alpha L A^2} = \left(\frac{\alpha}{2048\pi^5\Omega^4}\right)\ \frac{m^{14/5}}{t^{7/15}} \tag{87}$$

$$e^* = AT = \left(\frac{128\pi^4\Omega^3}{\alpha}\right)\ \frac{t^{3/5}}{m^{3/5}} \tag{88}$$

$$h^* = 2\pi LVM = (8\pi^4\Omega^4)\ m^{11/5}t^{7/15} \tag{89}$$

$$k_B^* = \frac{\pi VM}{A} = \left(\frac{\alpha}{32\pi\Omega}\right)\ m^{11/5}t^{2/15} \tag{90}$$

$$c,\ units = \frac{k^{3/5}}{t^{4/15}} = \frac{m}{s} \tag{91}$$

$$\mu_0,\ units = \frac{k^{14/5}}{t^{7/15}} = \frac{kg.m}{s^2A^2} \tag{92}$$

$$(R^{-1}),\ units = k^{3/5}t^{11/15} = m \tag{93}$$

Planck constant

$$h^3 = \frac{2\pi^{10}\mu_0^3}{3^6c^5\alpha^{13}R^2},\ units = k^{33/5}t^{7/5} \tag{94}$$

Elementary charge

$$e^3 = \frac{4\pi^5}{3^3c^4\alpha^8R},\ units = \frac{t^{9/5}}{k^{9/5}} \tag{95}$$

Boltzmann constant

$$k_B^3 = \frac{\pi^5\mu_0^3}{3^32c^4\alpha^5R},\ units = k^{33/5}t^{2/5} \tag{96}$$

Gravitation constant

$$G^5 = \frac{\pi^3\mu_0}{2^{20}3^6\alpha^{11}R^2},\ units = k^4t \tag{97}$$

Electron mass

$$m_e^3 = \frac{16\pi^{10}R\mu_0^3}{3^6c^8\alpha^7},\ units = k^3 \tag{98}$$

6.2. Constants in terms of velocity and momentum v, p

v_{SI} = 299792458 m/s;
p_{SI} = 1.01911341099 sqrt(kg.m/s);

$$P = (\Omega)p,\ (sqrt\ of\ momentum) \tag{99}$$

$$V = (2\pi\Omega^2)v,\ (velocity) \tag{100}$$

$$M = (1)\ \frac{p^2}{v},\ (mass) \tag{101}$$

$$T = (2\pi)\ \frac{p^{9/2}}{v^6},\ (time) \tag{102}$$

$$L = \frac{TV}{2} = (2\pi^2\Omega^2)\ \frac{p^{9/2}}{v^5},\ (length) \tag{103}$$

$$A = \frac{8V^3}{\alpha P^3} = \left(\frac{64\pi^3\Omega^3}{\alpha}\right)\ \frac{v^3}{p^3},\ (ampere) \tag{104}$$

$$G^* = \frac{V^2L}{M} = (8\pi^4\Omega^6)\ \frac{p^{5/2}}{v^2} \tag{105}$$

$$T_P^* = \frac{AV}{\pi} = \left(\frac{128\pi^3\Omega^5}{\alpha}\right)\ \frac{v^4}{p^3} \tag{106}$$

$$\mu_0^* = \frac{\pi V^2 M}{\alpha L A^2} = \left(\frac{\alpha}{2048\pi^5\Omega^4}\right)\ p^{7/2} \tag{107}$$

$$e^* = AT = \left(\frac{128\pi^4\Omega^3}{\alpha}\right)\ \frac{p^{3/2}}{v^3} \tag{108}$$

$$h^* = 2\pi LVM = (8\pi^4\Omega^4)\ \frac{p^{13/2}}{v^5} \tag{109}$$

$$k_B^* = \frac{\pi VM}{A} = \left(\frac{\alpha}{32\pi\Omega}\right)\ \frac{p^5}{v^3} \tag{110}$$

$$c,\ units = v,\ (\frac{m}{s}) \tag{111}$$

$$\mu_0,\ units = p^{7/2},\ (\frac{kg.m}{s^2A^2}) \tag{112}$$

$$R^{-1},\ units = \frac{p^{9/2}}{v^5},\ (m) \tag{113}$$

Planck constant

$$h^3 = \frac{2\pi^{10}\mu_0^3}{3^6c^5\alpha^{13}R^2},\ units = \frac{p^{39/2}}{v^{15}} \tag{114}$$

Elementary charge

$$e^3 = \frac{4\pi^5}{3^3c^4\alpha^8R},\ units = \frac{p^{9/2}}{v^9} \tag{115}$$

Boltzmann constant

$$k_B^3 = \frac{\pi^5\mu_0^3}{3^32c^4\alpha^5R},\ units = \frac{p^{15}}{v^9} \tag{116}$$

Gravitation constant

$$G^5 = \frac{\pi^3\mu_0}{2^{20}3^6\alpha^{11}R^2},\ units = \frac{p^{25/2}}{v^{10}} \tag{117}$$

Electron mass

$$m_e^3 = \frac{16\pi^{10}R\mu_0^3}{3^6c^8\alpha^7},\ units = \frac{p^{30}}{v^{15}} \tag{118}$$

Planck time

$$t_p^{15} = \frac{\pi^{22}\mu_0^9}{2^{20}3^{24}c^{50}\alpha^{49}R^8}, units = \frac{p^{135/2}}{v^{90}} \tag{119}$$

Planck mass

$$m_P^{15} = \frac{2^{25}\pi^{13}\mu_0^6}{3^6c^5\alpha^{16}R^2},\ units = \frac{p^{30}}{v^{15}} \tag{120}$$

6.3. Example formulas in terms of Q;

$$\alpha = \frac{2h}{\mu_0 e^2 c} = 2.2\pi Q^2 2\pi l_p.\frac{32 l_p c^5}{\pi^2\alpha Q^8}.\frac{\alpha^2 Q^6}{256 l_p^2 c^4}.\frac{1}{c} = \alpha \tag{121}$$

$$c = \frac{1}{\sqrt{\mu_0\epsilon_0}};\ \mu_0\epsilon_0 = \frac{\pi^2\alpha Q^8}{32 l_p c^5}\ \frac{32 l_p c^3}{\pi^2\alpha Q^8} = \frac{1}{c^2} \tag{122}$$

$$E_n = -\frac{2\pi^2 k_e^2 m_e e^4}{h^2 n^2} = -\frac{m_e c^2}{2\alpha^2 n^2} \tag{123}$$

$$E_n = -2\pi^2\ \frac{\pi^2\alpha^2 Q^{16}}{16384 l_p^2 c^6}\ m_e\ \frac{65536 l_p^4 c^8}{\alpha^4 Q^{12}}\ \frac{1}{4\pi^2 Q^4 4\pi^2 l_p^2} \tag{124}$$

$$q_p = \sqrt{4\pi\epsilon_0\hbar c} = \sqrt{4\pi\ \frac{32 l_p c^3}{\pi^2\alpha Q^8}\ 2\pi Q^2 l_p\ c} = \sqrt{\alpha}e \tag{125}$$

$$r_e = \frac{e^2}{4\pi\epsilon_0 m_e c^2} = \frac{256 l_p^2 c^4}{\alpha^2 Q^6}\ \frac{1}{4\pi}\ \frac{\pi^2\alpha Q^8}{32 l_p c^3}\ \frac{1}{m_e c^2} = \frac{l_p m_P}{\alpha m_e} \tag{126}$$

$$\frac{4\pi\epsilon_0 G m_e m_p}{e^2} = 4\pi\ \frac{32 l_p c^3}{\pi^2\alpha Q^8}\ \frac{l_p c^3}{2\pi Q^2}\ m_e m_p\ \frac{\alpha^2 Q^6}{256 l_p^2 c^4} = \frac{\alpha m_e m_p}{m_P^2} \tag{127}$$

$$m_P = \frac{B^2 r^2 e^2}{2E_p} = \frac{\pi^2\alpha^2 Q^{10}}{64 l_p^4 c^4}\ l_p^2\ \frac{256 l_p^2 c^4}{\alpha^2 Q^6}\ \frac{1}{2\pi Q^2 c} = \frac{2\pi Q^2}{c} \tag{128}$$

This essay has been adapted from the book Plato's Cave: The Mathematical Universe [6]

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