Planck unit theory: Fine structure constant alpha and sqrt of Planck momentum

Malcolm Macleod

e-mail: mail4malcolm@gmx.de

The primary constants; G, c, h, e, α, k_B, m_e... range in precision from low G (4-digits) to exact values (c, μ_0). A principle constraint with constructing a Planck unit theory is that the Planck units are limited to the precision of G and so to 4-digits which in turn limits the usefulness of Planck theories. By postulating the sqrt of Planck momentum Q as a link between mass and charge, we can formulate the above primary constants as geometrical shapes and then define them in terms of the 4 most accurate constants c (exact), permeability of vacuum μ_0 (exact), Rydberg constant (12 digit precision) and the fine structure constant alpha α (10 digit precision) giving us solutions to the Planck units whose precision is limited only by the precision of alpha. A resultant Planck unit theory emerges which suggests that particles are dimensionless formulas dictating the frequency of Planck events via a periodic (analog) electric wave-state to digital (integer) Planck-time-mass point-state oscillation. The dimensions of our universe then reduce to the 3 units (dimensions) of motion; Planck momentum, Planck time and velocity c.

1 Introduction

J. Barrow et al noted in a Scientific American article... '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.' [1]

2 Quintessence momentum

Planck momentum (velocity*mass) = $2.\pi.Q^2$ [19]

$$Q = 1.019\ 113\ 4112...\ units = \sqrt{\frac{kg.m}{s}} \tag{1}$$

3 Mass constants

Defining in terms of Planck momentum (instead of Planck mass), the mass constants as Planck units become;

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

$$G = \frac{l_p.c^3}{2.\pi.Q^2} \tag{3}$$

$$h = 2.\pi.Q^2.2.\pi.l_p \tag{4}$$

$$t_p = \frac{2.l_p}{c} \tag{5}$$

$$F_p = \frac{E_p}{l_p} = \frac{2.\pi.Q^2}{t_p} \tag{6}$$

4 Ampere A_Q

(Proposed) Ampere A_Q = velocity/mass [19]

$$A_Q = \frac{8.c^3}{\alpha.Q^3},\ units = \frac{m^2}{kg.s^2.\sqrt{(kg.m/s)}} = (\sqrt{\frac{m}{kg.s}})^3 \tag{7}$$

Where:

Planck Temperature = $A_Q\ .\ c$

Elementary charge = $A_Q\ .\ t_p$

Magnetic monopole (quark) = $A_Q.c.t_p = A_Q\ .\ l_p$

Electron = $t_p\ .\ (A_Q\ .\ l_p)^3$

Magneton = $A_Q\ .\ l_p^2$

5 Elementary charge

$$e = A.s = A_Q.t_p$$

$$e = \frac{8.c^3}{\alpha.Q^3}.\frac{2.l_p}{c} = \frac{16.l_p.c^2}{\alpha.Q^3},\ units = \frac{m^2}{kg.s.\sqrt{(kg.m/s)}} \tag{8}$$

6 Vacuum permeability

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.

$$\frac{F_{electric}}{A_Q^2} = \frac{2.\pi.Q^2}{\alpha.t_p}.(\frac{\alpha.Q^3}{8.c^3})^2 = \frac{\pi.\alpha.Q^8}{64.l_p.c^5} = \frac{2}{10^7} \tag{9}$$

gives:

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

$$\epsilon_0 = \frac{32.l_p.c^3}{\pi^2.\alpha.Q^8} \tag{11}$$

$$k_e = \frac{\pi.\alpha.Q^8}{128.l_p.c^3} \tag{12}$$

$$\alpha = \frac{2.h}{\mu_0.e^2.c} = 2.2.\pi.Q^2.2.\pi.l_p.\frac{32.l_p.c^5}{\pi^2.\alpha.Q^8}.\frac{\alpha^2.Q^6}{256.l_p^2.c^4}.\frac{1}{c} = \alpha \tag{13}$$

$$\mu_0.\epsilon_0 = \frac{\pi^2.\alpha.Q^8}{32.l_p.c^5}.\frac{32.l_p.c^3}{\pi^2.\alpha.Q^8} = \frac{1}{c^2} \tag{14}$$

$$c = \frac{1}{\sqrt{\mu_0.\epsilon_0}} = c \tag{15}$$

7 Planck length l_p

l_p in terms of $Q,\ \alpha,\ c$.
The magnetic constant μ_0 has a fixed value. From eqn.10

$$l_p = \frac{\pi^2.\alpha.Q^8}{2^7.\mu_0.c^5} \tag{16}$$

$$\mu_0 = 4.\pi.10^{-7}\ N/A^2$$

$$l_p = \frac{5^7.\pi.\alpha.Q^8}{c^5} \tag{17}$$

8 Planck Temperature T_P

T_P in terms of $Q,\ \alpha,\ c$.

$$T_P = \frac{8.c^4}{\pi.\alpha.Q^3} = \frac{A_Q.c}{\pi}; units = K \tag{18}$$
$$T_P = A.m/s$$

Boltzmann's constant k_B [20].

$$k_B = \frac{E_p}{T_P} = \frac{\pi^2.\alpha.Q^5}{4.c^3} = \frac{\pi.m_P.c}{A_Q}; units = J/K \tag{19}$$

Stefan-Boltzmann constant σ [22]

$$\sigma = \frac{2.\pi^5.k_B^4}{15.h^3.c^2} = \frac{2.\pi^2.m_P}{15.t_p^3.T_P^4} \tag{20}$$

Wien's constant b (x = 4.965114231744276)

$$b = \frac{2.\pi.l_p.T_P}{x} = \frac{2.l_p.A_Q.c}{x} \tag{21}$$
$$b = A.m^2/s$$

9 Planck mass black hole

Black hole energy distribution of emission T as described by Planck's law for M = m_P

$$T = \frac{h.c^3}{16.\pi^2.G.k_B.M} = \frac{T_P}{8.\pi} \tag{22}$$

Hawking radiation has a blackbody (Planck) spectrum with a temperature T for an M = m_P black hole ($r_s = 2.l_p$) given by

$$k_B.T = \frac{h.c}{8.\pi^2.r_s} = \frac{E_p}{8.\pi} \tag{23}$$

From eq.19 and eq.22

$$k_B.T = \frac{\pi^2.\alpha.Q^5}{4.c^3}\ .\ \frac{T_P}{8.\pi} = \frac{E_p}{8.\pi} \tag{24}$$

General relativity

$$\frac{c^4}{8.\pi.G} = \frac{F_p}{8.\pi} \tag{25}$$

Bekenstein–Hawking entropy (S) for M = m_P

$$A = \frac{16.\pi.G^2.m_P^2}{c^4} \tag{26}$$

$$S = \frac{2.\pi.k_B.c^3.A}{4.G.h} = 4.\pi.k_B \tag{27}$$

Angular momentum J = Diracs constant

$$\frac{J}{M.c} = l_p \tag{28}$$

Charged

$$r_Q^2 = \frac{e^2.G}{4.\pi.\epsilon_0.c^4} = \frac{l_p^2}{\alpha} \tag{29}$$

10 Electron as magnetic monopole

m_e in terms of $m_P,\ t_p,\ \alpha,\ e,\ c$. [19]
The ampere-meter is the SI unit for pole strength (the product of charge and velocity) in a magnet ($A.m = e.c$). A Magnetic monopole [4] is a hypothetical particle that is a magnet with only 1 pole.
To convert Planck time t_p, elementary charge e and speed of light c to SI units $1s, 1C, 1m/s$ requires dimensionless numbers which are numerically equivalent (t_x, e_x, c_x).

$$\frac{t_p}{t_x} = \frac{5.3912...e^{-44}s}{5.3912...e^{-44}} = 1s$$

$$\frac{e}{e_x} = \frac{1.6021764...e^{-19}C}{1.6021764...e^{-19}} = 1C$$

$$\frac{c}{c_x} = \frac{299792458m/s}{299792458} = 1m/s$$

Dimensionless formulas for a magnetic monopole σ_e and an electron E_σ are proposed.

$$\sigma_e = \frac{2.\pi^2}{3.\alpha^2.e_x.c_x} = \frac{\pi^2.Q_x^3}{24.\alpha.l_x.c_x^3} = A.(m/s).s = A.m \tag{30}$$

$$E_\sigma = t_x.\sigma_e^3 = \frac{\pi^6.Q_x^9}{2^8.3^3.\alpha^3.l_x^2.c_x^{10}} \tag{31}$$

Planck mass:

$$m_e = m_P.E_\sigma \tag{32}$$

Compton wavelength:

$$\lambda_e = \frac{2.\pi.l_p}{E_\sigma} \tag{33}$$

Frequency:

$$T_e = \frac{2.\pi.l_p}{E_\sigma.c} = \frac{t_p}{E_\sigma} = \frac{1}{\sigma_e^3}.\frac{t_p}{t_x} \tag{34}$$

Gravitation coupling constant:

$$\alpha_G = (\frac{m_P.E_\sigma}{m_P})^2 = E_\sigma^2 \tag{35}$$

para-positronium lifetime:

$$t_0 = \frac{\alpha^5}{\sigma_e^3}.\frac{t_p}{t_x} \tag{36}$$

ortho-positronium lifetime:

$$t_1 = \frac{9.\pi.\alpha^6}{4.\sigma_e^3.(\pi^2-9)}.\frac{t_p}{t_x} \tag{37}$$

Up-quark

$$\sigma^2$$

Down quark

$$\sigma^{-1}$$

A $t_x.\sigma_e^2$ particle would have only 1 space dimension and a mass in the neutrino mass range; $m_e * 10^{-7}$ to 10^{-9}kg.

A $t_x.\sigma_e^4$ particle would have 3 space dimensions and a mass in the top quark range; $m_e * 10^7$kg.

A $t_x.\sigma_e^1$ particle would have 0 space dimensions. It is the inverse of Planck temperature. This suggests there may be a temperature particle, i.e.: a 'kelvon'.

A baseline $t_x.\sigma_e$ particle (eq.18, eq.22);

$$t_x.\sigma_e = \frac{2.\pi^2}{3.\alpha^2.A_Q.c} = \frac{2.\pi}{3.\alpha^2.T_P} \tag{38}$$

$$E = E_p.t_x.\sigma_e = \frac{2.\pi.E_p.}{3.\alpha^2.T_P} = \frac{2.\pi.k_B}{3.\alpha^2} \tag{39}$$

This 'kelvon' compares with the lowest possible temperature [22].

$$t_{min} = \frac{8.\pi}{T_P} = 0.177\ 10^{-30}\ K \tag{40}$$

11 Bohr magneton

$$\mu = \frac{e.h.n}{4.\pi.m_e} = \frac{8.m_P.l_p^2.c^3}{\alpha.Q^3.m_e} = \frac{A_Q.l_p^2}{E_\sigma} = \frac{A_Q.l_p.c}{\sigma_e^3}.\frac{t_p}{t_x} \tag{41}$$

$$\mu = A.m^2$$

12 Radio wave

$$B_{1Tesla} = \frac{l_x^2.c_x^2.Q^5}{l_p^2.c^2.Q_x^5} \tag{42}$$

$$\mu_B = \frac{e.h}{4.\pi.m_e} \tag{43}$$

Larmor precession frequency (1 Tesla) f_L = 28.025GHz, k_{Bx} is the dimensionless Boltzmanns constant and γ is the electron magnetic moment γ = 1.001 159 652 180 73(28).

$$f_L = \frac{\gamma.2.\mu_B.B_{1Tesla}}{h} = \frac{\gamma.4.l_x^2.c_x^2.m_P.c}{\pi^2.\alpha.l_p.Q_x^5.m_e} = \frac{\gamma.c_x}{2.k_{Bx}.\sigma_e^3}.\frac{t_x}{t_p} \tag{44}$$

The presence of the Boltzmann's constant is a consequence of the SI unit 1 Tesla. A Planck B_P (R_P = Planck Rydberg)

$$B_P = \frac{m_P}{\alpha^2.A_Q.t_p^2} \tag{45}$$

$$f_P = \frac{2.\mu_B.B_e}{h} = \frac{1}{2.\pi.\alpha^2.t_p} = \frac{c}{4.\pi.\alpha^2.l_p} = R_P.c \tag{46}$$

A Planck electron B_e (R_∞ = Rydberg constant)

$$B_e = \frac{m_P.m_e^2}{\alpha^2.A_Q.t_p^2.m_P^2} = \frac{m_P.t_x^2.\sigma_e^3}{\alpha^2.A_Q.t_p^2} \tag{47}$$

$$f_e = \frac{2.\mu_B.B_e}{h} = \frac{m_e.c}{4.\pi.\alpha^2.l_p.m_P} = R_\infty.c \tag{48}$$

13 Reduced formulas

Replacing l_p with eqn.16, the natural constants can be reduced to $Q,\ \alpha,\ c$

$$h = \frac{2^2.5^7.\pi^3.\alpha.Q^{10}}{c^5} \tag{49}$$

$$e = \frac{2^4.5^7.\pi.Q^5}{c^3} \tag{50}$$

$$m_e = m_P.\ \frac{\pi^4}{2^8.3^3.5^{14}.\alpha^5.Q_x^7} \tag{51}$$

The Rydberg constant R_∞

$$R_\infty = \frac{m_e.e^4.\mu_0^2.c^3}{8.h^3} = \frac{\pi^2.c^5}{2^{10}.3^3.5^{21}.\alpha^8.Q^8.Q_x^7} \tag{52}$$

14 von Klitzing constant

The von Klitzing constant reduces to α and c and so has the potential to provide the most definitive solution for α.

$$R_K = \frac{h}{e^2} = \frac{\pi.\alpha.c}{5000000} \tag{53}$$

R_K = 25812.807 557(18) [17]

$$\alpha = 137.035\ 999\ 677(96)$$

15 Fine structure constant alpha

The von Klitzing alpha (above) is close to the following;
$\alpha = (17^4 + 11)/(c.\phi.\mu_0)$ = 137.035 999 768 293...
and James Gilson [18]
α = 137.035 999 786 699...

Atom-recoil measurements:
$h/R_b = 4.5913592729e - 9$amu
$87R_b$ = 86.909180527amu
m_e = 0.000548579909067amu
$\alpha = 1/\sqrt{((2.R_\infty/c).h/R_b.87R_b/m_e)}$
α = 137.035 998 998

h/neutron ratio [24]
$h/m_n = 3.956033332e - 7$amu
m_n = 1.00866491600amu
$\alpha = 1/\sqrt{((2.R_\infty/c).h/m_n.m_n/m_e)}$
α = 137.036 010 857

16 Quintessence momentum

The Rydberg constant R_∞ = 10 973 731.568 539(55) [5] with a 12-digit precision is the most accurate of the natural constants. consequently we may re-define Q in terms of this constant, c and α.

$$Q^{15} = \frac{\pi^2.c^5}{2^{10}.3^3.5^{21}.\alpha^8.R_\infty} \tag{54}$$

$$Q = (\frac{\pi^2.c^5}{2^{10}.3^3.5^{21}.\alpha^8.R_\infty})^{\frac{1}{15}} \tag{55}$$

17 Cosmological constant Ω

We can use eq.22 to solve the CMB cosmic microwave background temperature [22]. This then permits us to determine the maximum age of the universe t_u (in units of Planck time) being when the CMB temperature reaches the lowest possible temperature and the universe can expand no further [19].

$$t_u = \Omega = (\frac{T_P}{8.\pi})^4 = 0.10137\ 10^{124} \tag{56}$$

18 Numerical solutions

CODATA 2010 values
α = 137.035 999 074(44) [7]
R_∞ = 10 973 731.568 539(55) [5]
h = 6.626 069 57(29) $e - 34$ [6]
e = 1.602 176 565(35) $e - 19$ [9]
m_e = 9.109 382 91(40) $e - 31$ [10]
G = 6.673 84(80) $e - 11$ [12]
$\mu_0 = 4.\pi/10^7$
k_B = 1.380 6488(13) $e - 23$ [13]

using α = 137.035 999 074
R_∞ = 10 973 731.568 539
$\mu_0 = 4.\pi/10^7$

gives
h = 6.626 069 148 $e - 34$
e = 1.602 176 513 $e - 19$
m_e = 9.109 382 323 $e - 31$
G = 6.672 497 199 $e - 11$
k_B = 1.379 510 149 $e - 23$

Results agree precisely with CODATA 2010 values except for G and k_B.

G: The same inputs were used to solve Planck constant, the electron wavelength and electron mass and so by extension the Rydberg constant; and these 4 values all have the requisite precision. We may also note that the calculated G agrees with the Sandia National Laboratories G;

Parks et al $G = 6.672\ 34(21)\ e - 11$ [14]

k_B: This value assumes idealized 'Planck' conditions. Accuracy is within 1.0008254 of CODATA 2010 value. However when used to solve the Larmor frequency, accuracy improves to 28.024954/28.024944 = 1.000000357.

Refer to the website [19] for further details and a complete list of calculated constants.

19 Summary

The 3 units of motion; Planck momentum, Planck time and c formed the mass domain. From the sqrt of Planck momentum Q, c and alpha was formed an ampere. From this ampere, Planck time and c was formed the charge domain which includes particles and particle properties. As only the ampere formula was hypothesised, i.e.: the other formulas were all derived, and as the ampere has a simple cubic geometry, and as all results are within CODATA precision, I argue that the significance of this approach cannot be easily dismissed as numerology but rather deserves futher analysis.

A universe whose dimensions are motion also suggests a Planck unit theory and a Mathematical Universe Hypothesis MUH [21].

Maple code:

$pi := 3.14159265358979323846 26$:
$c := 299792458$:
$a := 137.035999074$:
$R := 10973731.568539$:

$Q := (pi^2 * c^5/(2^{10} * 3^3 * 5^{21} * a^8 * R))^{(1/15)}$:
$lp := (5^7 * pi * a * Q^8/c^5)$:
$mP := (2 * pi * Q^2/c)$:
$tp := 2 * lp/c$:
$Aq := 8 * c^3/(a * Q^3)$:

$G = c^2 * lp/mP$
$e = 16 * lp * c^2/(a * Q^3)$
$h = 2 * pi * Q^2 * 2 * pi * lp$
$m_e = mP * tp * (pi^2 * Q^3/(24 * a * lp * c^3))^3$
$kB = pi^2 * a * Q^5/(4 * c^3)$

References

1. SciAm 06/05, P57: Constants, J Barrow, J Webb
2. hyperphysics.phy-astr.gsu.edu/hbase/electric/elefie.html
3. http://en.wikipedia.org/wiki/Planck-force
4. en.wikipedia.org/wiki/Magnetic-monopole
5. http://physics.nist.gov/cgi-bin/cuu/Value?ryd
6. http://physics.nist.gov/cgi-bin/cuu/Value?ha
7. http://physics.nist.gov/cgi-bin/cuu/Value?alphinv
8. http://physics.nist.gov/cgi-bin/cuu/Value?plkl
9. http://physics.nist.gov/cgi-bin/cuu/Value?e
10. http://physics.nist.gov/cgi-bin/cuu/Value?me
11. http://physics.nist.gov/cgi-bin/cuu/Value?mu0
12. http://physics.nist.gov/cgi-bin/cuu/Value?bg
13. http://physics.nist.gov/cgi-bin/cuu/Value?k
14. Parks, H. V, Faller, J. E. Phys. Rev. Lett. http://xxx.lanl.gov/abs/1008.3203 (2010)
15. A. M. Jeffery, R. E. Elmquist, L. H. Lee, J. Q. Shields, and R. F. Dziuba, IEEE Trans. Instrum. Meas. 46, 264, (1997).
16. http://www.nature.com/nature/journal/v473/n7348/full/nature10104.html
17. A. Tzalenchuk et al, Towards a quantum resistance standard based on epitaxial graphene, Nature Nanotechnology 5, 186 - 189 (2010)
18. http://www.fine-structure-constant.org/page5A.html
19. http://www.planckmomentum.com/
20. private correspondence (Marian Gheorghe)
21. M. J. Macleod, Plato's Cave: the geometry of momentum (2013 edition)
    http://www.platoscode.com/
22. M.J.Macleod, Time and the black hole universe http://vixra.org/abs/1310.0191
23. M.J.Macleod, Nuclear, Atomic, Molecular, Gravitational Orbitals as Anti-Photons
    http://vixra.org/abs/1308.0140
24. E Kruger et al 1998 Metrologia 35 203