We Produce the Values of Physical Constants and Make Physical Laws

B. F. Riley

Any number, *N*, such as the numerical value of a physical constant measured in any units, will be mapped by any function, *f*, of the observer's choice to a rational number, *n*, that will lie within any infinitely-divisible discrete framework of the observer's choice. Although all numbers *N* map to numbers *n* that lie within the framework, *interesting* *N* map to *n* that are integers, or fractions of low denomination. The value of *n* explains the value of *N* in terms of the function *f*. For this observer, numbers *N* that characterise particularly interesting quantities often are found to map to numbers *n* that are precisely multiples of 25. Many examples are shown, where *N* is the numerical value of a quantity measured in Planck, SI or diverse other units. Physical constants whose values have been produced by means of *conceptual observation* conform to all of reality as known by the observer – hence the apparent fine-tuning of the universe for life. Because physical constants hold good for all time, past and future, it seems that time is an intuition of the observer, as argued by Kant. Conceptual observation has been used to correlate physical parameters, with implications for the origin of physical laws.

In the Critique of Pure Reason [1], Kant said:

> Our cognition arises from two fundamental sources in the mind, the first of which is the reception of representations (the receptivity of impressions), the second the faculty for cognizing an object by means of these representations (spontaneity of concepts); through the former an object is **given** to us, through the latter it is **thought** in relation to that representation (as a mere determination of the mind). Intuition and concepts therefore constitute the elements of all our cognition, so that neither concepts without intuition corresponding to them in some way nor intuition without concepts can yield a cognition.

Observation in conjunction with a concept – conceptual observation – gives a quantity its value in the *phenomenal world*[1] of the observer [2, 3]. The numerical value, *N*, of the quantity in any units maps by a function, *f*, of the observer's choice to a rational number, *n*, within an infinitely-divisible discrete framework of the observer's choice [4]. The value of *n* explains the value of *N* in terms of *f*. The mapping has usually been to the exponent of a base chosen by the observer. If the observed quantity is of particular interest to the observer its numerical value, *N*, will map to a conspicuous number *n*, such as an integer or a fraction of low denomination, as long as the value of the quantity is compatible with the phenomenal world of the observer. The numerical values, N_1 and N_2, of two quantities that describe a pair of objects, such as the masses of the quarks of each family, usually map (by the same

[1] For Kant, reality in itself – the *noumenal world* – is unknown to us.

function) to numbers n_1 and n_2 that are symmetrically arranged about an integer, or a fraction of low denomination. Symmetry has featured in this work since the beginning [5].

Since 2013, when the numerical value of the Bohr radius in Planck units, $N = a_0/l_{\text{Planck}}$, was found to map to $n = 125$ by application of the function $f: N \rightarrow \ln(N)/\ln(\pi/2)$, i.e. $N = (\pi/2)^{125}$ [6], the numerical values of the most interesting quantities have often been found to map to values of *n* that are multiples or powers of 25. The numerical values of many other interesting quantities have been found to map to values of *n* that are multiples or powers of 5. Occasionally, the resulting expression for *N* includes an interesting factor, such as α. Conceptual observation has been used to produce the values of a wide variety of interesting quantities, many of which are physical constants. For the phenomenal world of the observer to make sense, the physical constants whose values have been produced by means of conceptual observation must conform to all of reality as known by the observer – hence the apparent fine-tuning of the universe for life.

The expressions produced for a selection of quantities are shown in the equations below; all figures in the exponents are significant, all exponents of α being exact. The use of bases π, π/2 and e was established in the early years of this work [7]; other bases have now also been used. The particle data used here are the current evaluations of the Particle Data Group [8]. The values of the Planck units are those of CODATA [9]. Solar system parameters are taken from the NASA planetary factsheets [10].

Using Planck units:

- Bohr radius, $a_0 = (\pi/2)^{125.00}\, l_{\text{Planck}}$ (1)
- electron mass, $m_{\text{e}} = \alpha^{-1}(\pi/2)^{-125.00}\, m_{\text{Planck}}$; also $\pi^{-45.01}\, m_{\text{Planck}}$ (2)
- up quark mass (2.16 MeV), $m_{\text{u}} = \alpha(\pi/2)^{-100.02}\, m_{\text{Planck}}$; also $\text{e}^{-50.09}\, m_{\text{Planck}}$ (3)
- charm quark mass (1.27 GeV), $m_{\text{c}} = \alpha^2(\pi/2)^{-75.00}\, m_{\text{Planck}}$ (4)
- top quark mass (172.69 GeV), $m_{\text{t}} = \alpha(\pi/2)^{-75.02}\, m_{\text{Planck}}$ (5)
- $(m_{\text{u}} m_{\text{d}})^{1/2} = (\pi/2)^{-110.06}\, m_{\text{Planck}}$ (6)
- $(m_{\text{s}} m_{\text{c}})^{1/2} = \text{e}^{45.01}\, m_{\text{Planck}}$ (7)
- $(m_{\text{b}} m_{\text{t}})^{1/2} = (\pi/2)^{-90.03}\, m_{\text{Planck}}$ (8)
- Higgs boson mass (125.25 GeV), $m_{\text{H}} = 2^{25}(\pi/2)^{-125.00}\, m_{\text{Planck}}$ (9)
- GUT scale (2×10^{16} GeV), $m_{\text{GUT}} = \alpha^{-1}(\pi/2)^{-25.10}\, m_{\text{Planck}}$ (10)
- pion charge radius (0.659 fm), $r_\pi = (\pi/2)^{99.99}\, l_{Planck}$ (11)
- radius of the sun (6.957×10^5 km), $R_\odot = \text{e}^{100}\, l_{\text{Planck}}$ (12)

- Carrington rotation period of the sun (25.38 days), $P_{\odot,\mathrm{C}} = \pi^{99.8}\ t_{\mathrm{Planck}}$ (13)
- central temperature of the sun (1.571×10^7 K), $T_{\odot,\mathrm{c}} = \pi^{-50.2}\ T_{\mathrm{Planck}}$ (14)
- moment of inertia of the sun (6.737×10^{46} kg. m^2), $I_{\odot} = \pi^{250}\ I_{\mathrm{Planck}}$ [11] (15)

- angular momentum of the sun (1.930×10^{41} kg. m^2. s^{-1}), $\mathrm{S}_{\odot} = 2^{250.0}\ \hbar$ [11] (16)
- the angular momentum of each of the six nearest G and K-type stars to earth is equal to $2^n\ \hbar$, where *n* is an integer between 247 and 251 [10] (17)
- geometric mean orbital angular momentum of the eight planets, $\mathrm{L}_{8,\mathrm{mean}} = 2^{249.9}\ \hbar$ [11] (18)

- semi-major axis of the moon (0.3844×10^6 km), $a_{\mathrm{moon}} = \mathrm{e}^{99.9}\ l_{\mathrm{Planck}}$ (19)
- mean duration of a month (30.44 days), $t_{\mathrm{month}} = \pi^{99.9}\ t_{Planck}$ (20)

- total mass + energy of the observable universe (3.06×10^{54} kg, mass equivalent]), $M_{\mathrm{OU}} = \pi^{125.0}\ m_{\mathrm{Planck}}$ [12] (21)

Using SI units:

- Hartree energy, mass equivalent, (27.21 eV/c2), $E_{\mathrm{h}} = (\pi/2)^{-175.0}$ kg (22)
- up quark mass (2.16 MeV), $m_{\mathrm{u}} = (\pi/2)^{-150.0}$ kg (23)
- charm quark mass (1.27 GeV), $m_{\mathrm{c}} = \alpha(\pi/2)^{-125.0}$ kg (24)
- top quark mass (172.69 GeV), $m_{\mathrm{t}} = (\pi/2)^{-125.0}$ kg (25)

- Planck time, $t_{\mathrm{Planck}} = \mathrm{e}^{-100}$ s (26)
- Planck length, $l_{\mathrm{Planck}} = \pi^{-70.0}$ m; also $\mathrm{e}^{-80.1}$ m (27)
- Planck mass, $m_{\mathrm{Planck}} = \alpha^{-1}(\pi/2)^{-50.0}$ kg (28)
- Planck force (c^4/G), $F_{\mathrm{Planck}} = (\pi/2)^{225}$ N (29)
- Planck temperature, $T_{\mathrm{Planck}} = \alpha(\pi/2)^{175}$ K (30)

- mass of the earth, $M_{\mathrm{earth}} = \pi^{49.8}$ kg (31)
- surface area of the earth, $A_{\mathrm{earth}} = (\pi/2)^{75.0}$ m^2 (32)
- radius of the sun, $R_{\odot} = (\pi/2)^{45.1}$ m (33)

- gravitational binding energy of the sun (2.28×10^{41} J), $U_{\odot} = \alpha^{-1}(\pi/2)^{200}$ J (34)

- volume of the observable universe (3.57×10^{80} m^3), $V_{\mathrm{OU}} = \alpha^{-1}(\pi/2)^{400}$ m^3 (35)
- total mass + energy of the observable universe, mass equivalent, $M_{\mathrm{OU}} = \mathrm{e}^{125}$ kg (36)

Using other units:

- W boson mass (80.377 GeV), $m_{\mathrm{W}} = (\pi/2)^{25.0}$ MeV (37)
- Z boson mass (91.1876 GeV), $m_{\mathrm{Z}} = \pi^{9.98}$ MeV (38)
- speed of light, $\mathrm{c} = (\pi/2)^{45.0}$ mph (39)
- reduced Planck constant, $\hbar = \mathrm{e}^{-35.0}$ eV. s (40)
- age of the universe (13.787 Gyr), $t_{\mathrm{U}} = \alpha^{-2}(\pi/2)^{50.0}$ hours (41)

Four interesting lengths measured in Planck units – the mean distances from earth of the sun and moon, d_{sun} and d_{moon}, and the volumetric mean radii of the two bodies, r_{sun} and r_{moon} – have been subjected to conceptual observation with interesting results [13]. The numerical value, N, of each length is mapped to n_1 and n_3 by application of the functions $f_1: N \to \ln(N)/\ln(\pi)$ and $f_3: N \to \ln(N)$, i.e. $N = \pi^{n_1}$ and $N = \mathrm{e}^{n_3}$. The function values n_1 and n_3 for each length have been plotted one against the other in Figure 1. As a result of the almost perfect symmetry, which reflects the observer's judgement of the of the sun and moon as a *pair* of very interesting objects in earth's skies, one may write,

$$r_{\mathrm{sun}} \times d_{\mathrm{moon}} = r_{\mathrm{moon}} \times d_{\mathrm{sun}} \quad (51)$$

and therefore

$$r_{\mathrm{sun}}/d_{\mathrm{sun}} = r_{\mathrm{moon}}/d_{\mathrm{moon}} \quad (52)$$

which tells us the sun and the moon subtend the same solid angle at the surface of the earth, i.e. they appear to be the same size to an observer on earth. This curious fact can be explained by the conceptual observation of the four quantities considered above, because:

1. The measurement units, applied function and framework have all been chosen by the observer.
2. The function values lie in symmetrical arrangement within the framework. Symmetry results when the values of quantities that describe pairs of objects are conceptually observed.
3. The symmetry is about the conspicuous number $n_1 = 87.5$ at the interesting point (87.5, 100).

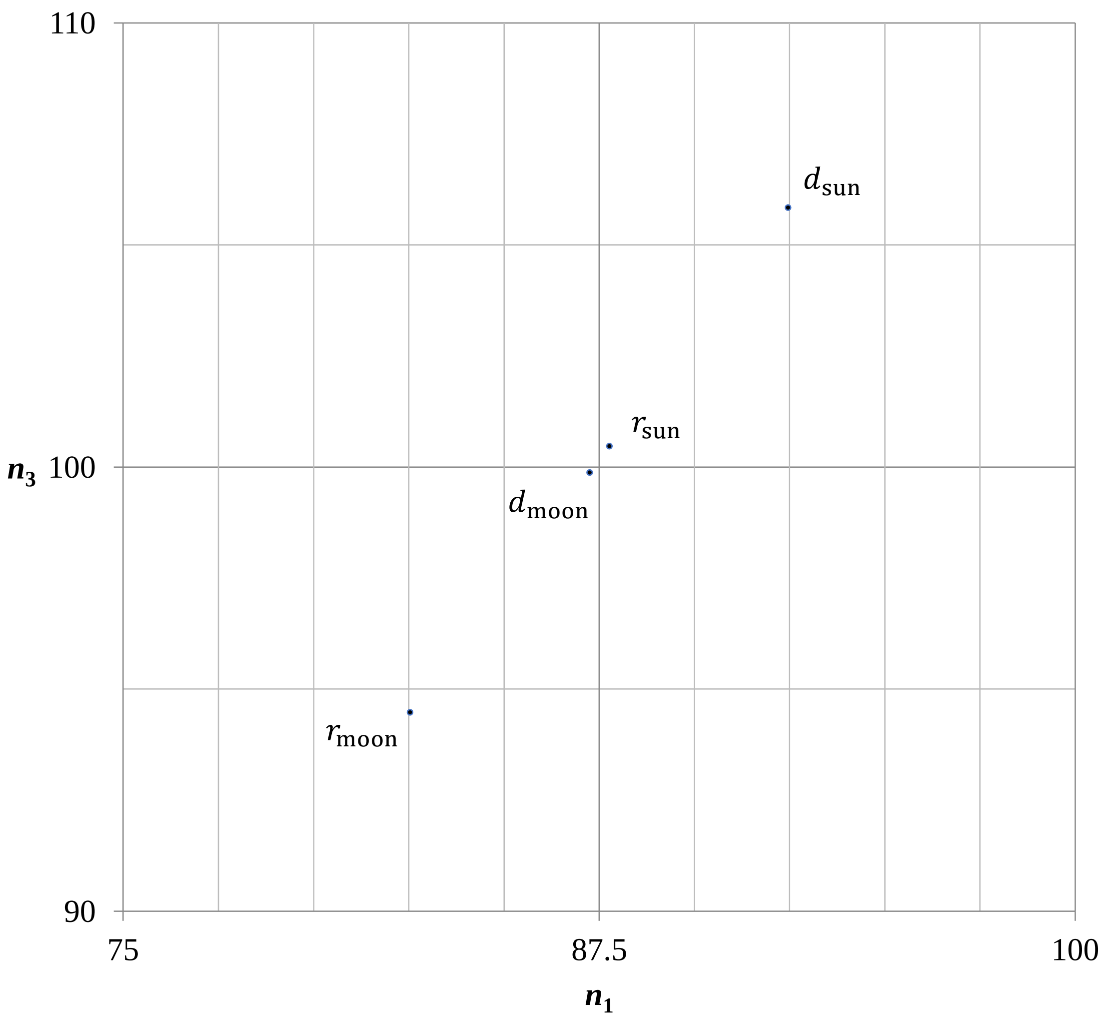

Figure 1: Values of n_1 and n_3 where the numerical value of a length in Planck units is equal to π^{n_1} and e^{n_3}

d_{sun}	Semi-major axis of earth's orbit (1.496×10^8 km)
r_{sun}	Volumetric mean radius of the sun (6.957×10^5 km)
d_{moon}	Semi-major axis of the moon's orbit (3.844×10^5 km)
r_{moon}	Volumetric mean radius of the moon, (1.737×10^3 km)

The reasoning concomitant with conceptual observation is generally based on what is already known. After finding that the Bohr radius is equal to $(\pi/2)^{125}\, l_{\text{Planck}}$, an equation for the mass of the electron was comprehended: $m_{\text{e}} = \alpha^{-1}(\pi/2)^{-125}\, m_{\text{Planck}}$. A factor α was then found in the equations for the up and top quark masses ($m_{\text{u}} = \alpha(\pi/2)^{-100}\, M_{\text{Planck}}$; $m_{\text{t}} = \alpha(\pi/2)^{-75}\, M_{\text{Planck}}$). Equations for the pion charge radius ($r_\pi = (\pi/2)^{100}\, l_{Planck}$) and the GUT scale in terms of the electron mass ($m_{\text{GUT}} = (\pi/2)^{100}\, m_{\text{e}}$) were then found consecutively. After finding that the angular momentum of the sun is equal to $2^{250}\, \hbar$, the angular momenta of the nearest G and K-type stars were found to be equal to integer powers of 2. The spin and orbital angular momenta of astronomical bodies in general were then found to be equal to rational powers of 2. The equation for the mass of the Higgs boson ($m_{\mathrm{H}} = 2^{25}(\pi/2)^{-125}\, m_{\mathrm{Planck}}$) was found immediately after finding that the masses m_{P4} and radii r_{P4}, in Planck units, of stable period 4 transition metal nuclides are related through the equation $m_{\mathrm{P4}} \approx 2^{25}/r_{\mathrm{P4}}$ [12]. One thing has led to another as the knowledge of the observer has broadened. All quantities: mean quantities, differences in quantities, quantities in any units, dimensionless quantities of all sorts, including random numbers, have been found to map to rational numbers by the application of functions of the observer's choice. Even the page numbers of a book on which particularly interesting subjects are introduced, and on which chapters commence, have been found to map to rational numbers within the observer's framework [14]. If a particularly interesting quantity, of numerical value *N*, can be accommodated within the phenomenal world of the observer so that the function value *n* takes a conspicuous value, then it will be.

One might reasonably ask how, for example, the Bohr radius can be precisely equal to $(\pi/2)^{125}\, l_{Planck}$ although it was given that value only in 2013? Kant gives us an explanation: time and space are the a priori intuitions through which the experiences of the observer are framed. In the phenomenal world of the observer, the Bohr radius, a physical constant, has always been equal to $(\pi/2)^{125}\, l_{Planck}$ and always will be. Not all physical quantities are physical constants, though. The angular momentum of the sun, for example, adopted its current value by conceptual observation in 2018 but because that value must make sense within the wider phenomenal world of the observer it will change in time as dictated by physical laws.

Conceptual observation has also been used to correlate physical quantities, numerically. The first, key, equation in the set that follows was found by reasoning that the dark energy density is related in size, using Planck units, to both the Bohr radius and the radius of the observable universe [15].

- the Bohr radius a_0 and the radius R_{OU} (46.5 Glyr) of the observable universe are precisely correlated through the equation $2{a_0}^5 = {R_{\mathrm{OU}}}^2$ (42)

After finding (42), a dual function + framework approach was used to produce four similarly constructed equations (in Planck units) that correlate small and large quantities, numerically:

- the Higgs field vacuum expectation value υ (246 GeV) and the geometric mean radius of the eight planets $R_{8,\mathrm{mean}}$ (12,992 km) are correlated through the equation
  $2\upsilon^{-5} = {R_{8,\mathrm{mean}}}^2$ [16] (43)

- the mass of the Higgs boson m_{H} and the volumetric mean radius of Jupiter R_{Jupiter} (69,911 km) are correlated through the equation $2{m_{\mathrm{H}}}^{-5} = {R_{\mathrm{Jupiter}}}^2$ [16] (44)

- the radii R_* of nearby G and K-type stars are precisely correlated with the atomic masses m_{sn} of specific stable period 4 transition metal nuclides through the equation

  $2m_{\text{sn}}^{-5} = R_*^{\ 2}$ [17] (45)

- the masses M_* of the G and K-type stars referred to in (45) are precisely correlated with the atomic radii r_{sn} of the period 4 transition metal nuclides referred to in (45) through the equation $2r_{\text{sn}}^{-5} = (\pi/2)^{250} M_*^{\ 2}$ [18] (46)

Any equation conceived in order to correlate parameters will do so as long as the observed values of the parameters are compatible with the phenomenal world of the observer. There is no explicit causal link between parameters in equations but in an equation conceived to represent a physical law there is an implied causal link.[2] The equations that represent physical laws are often of elegant form because they have been conceived in that form by an observer.

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[2] For Kant, causality is a pure concept of the understanding: an event must have a cause. [1]

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