All Measurement Outcomes are Subjective

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If all measurement outcomes are subjective to the observer then so too are the values of the speed of light, the gravitational constant and the reduced Planck constant, and consequently the values of the Planck length, Planck time and Planck mass as well. The values, as numbers of the common units of measurement, of these constants, particle masses, the distances from Earth and the masses of celestial bodies and objects, and the characteristic temperatures of cryogens, are expressed as powers of π, π/2 and e. The powers are found to take integer, half-integer, quarter-integer, etc values. There are obvious implications for the value of the CMB temperature.

Measurements of distance, elapsed time, mass and energy on all scales have been related to Planck scale through multiplication by powers of π, π/2 and e – bases that have been identified with interval lengths in a higher-dimensional geometry [1]. Since it seems that all measurement outcomes are subjective to the observer [2], the values as numbers of the common units of measurement [3], of the speed of light c = 299792458 $\mathrm{ms^{-1}}$, the gravitational constant G = 6.67430(15)×10^{-11} $\mathrm{m^3kg^{-1}s^{-2}}$, the reduced Planck constant ħ = 6.582119569…×10^{-16} eV.s, the Planck length $l_\mathrm{P} =$ 1.616255(18)×10^{-35} m, the Planck time $\mathrm{t_P} =$ 5.391247(60)×10^{-44} s, the Planck mass $\mathrm{m_P} =$ 1.220890(14)×10^{19} GeV and also 2.176434(24)×10^{-8} kg, and then various other measurements are expressed as powers, n_1, n_2 and n_3 of π, π/2 and e, respectively. The powers[1] are plotted on two-dimensional lattices of principal levels and sub-levels corresponding to the locations of integer, half-integer, quarter-integer, etc, powers in two of the three sequences at a time.

The value of c as numbers of $\mathrm{ms^{-1}}$, the value of G as numbers of $\mathrm{m^3kg^{-1}s^{-2}}$ and the value of ħ as numbers of eV.s are shown as powers n_1 and n_3 of π and e, respectively, in Figure 1. The values lie close to superlevels – levels whose level-numbers are integer multiples of 5. Superlevels are important locations for physics [4]. We see that c ~ e^{20} $\mathrm{ms^{-1}}$, G ~ π^{-20} $\mathrm{m^3kg^{-1}s^{-2}}$ and ħ ~ π^{-30} eV.s and ~ e^{-35} eV.s.

The Planck length as numbers of metres, the Planck time as numbers of seconds and the Planck mass as numbers of MeV and also as numbers of kilograms are shown as powers n_1 and n_3 of π and e, respectively, in Figures 2 and 3. We see that $l_\mathrm{P} \sim \pi^{-70}$ m and ~ e^{-80} m, $t_\mathrm{P} \sim \mathrm{e}^{-100}$ s, and $\mathrm{m_P} \sim \pi^{-15}$ kg, ~ π^{45} MeV and ~ e^{50} MeV.

[1] Properly, the exponents

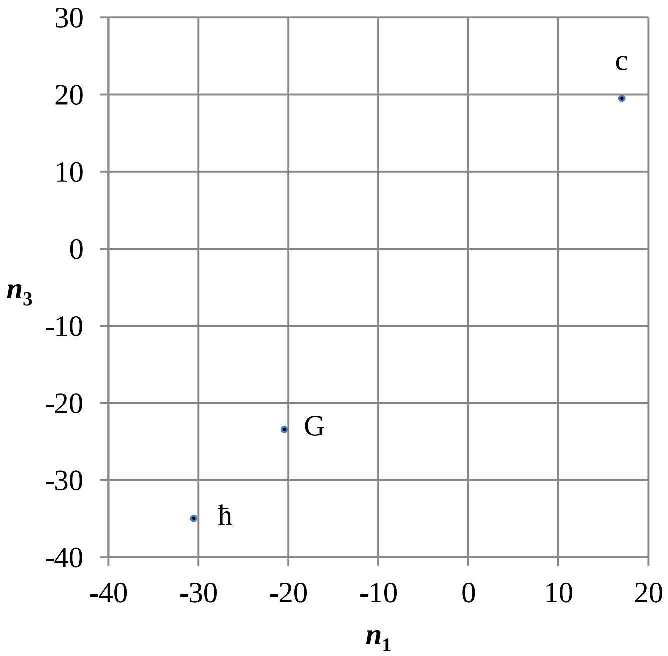

Figure 1: The speed of light c as numbers of ms^{-1}, the gravitational constant G as numbers of m^{3}kg^{-1}s^{-2} and the reduced Planck constant ħ as numbers of eV.s. Shown as powers n_1 and n_3 of π and e, respectively. The powers lie on a straight line since n_1 and n_3 are in constant ratio.

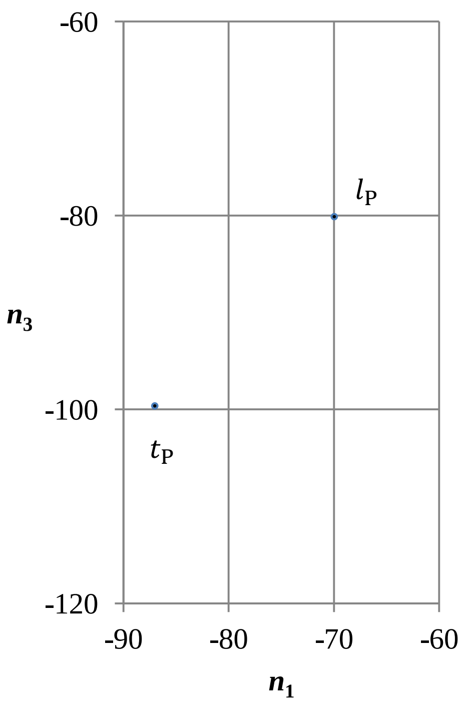

Figure 2: The Planck length l_P as numbers of metres and the Planck time t_P as numbers of seconds. Shown as powers n_1 and n_3 of π and e, respectively.

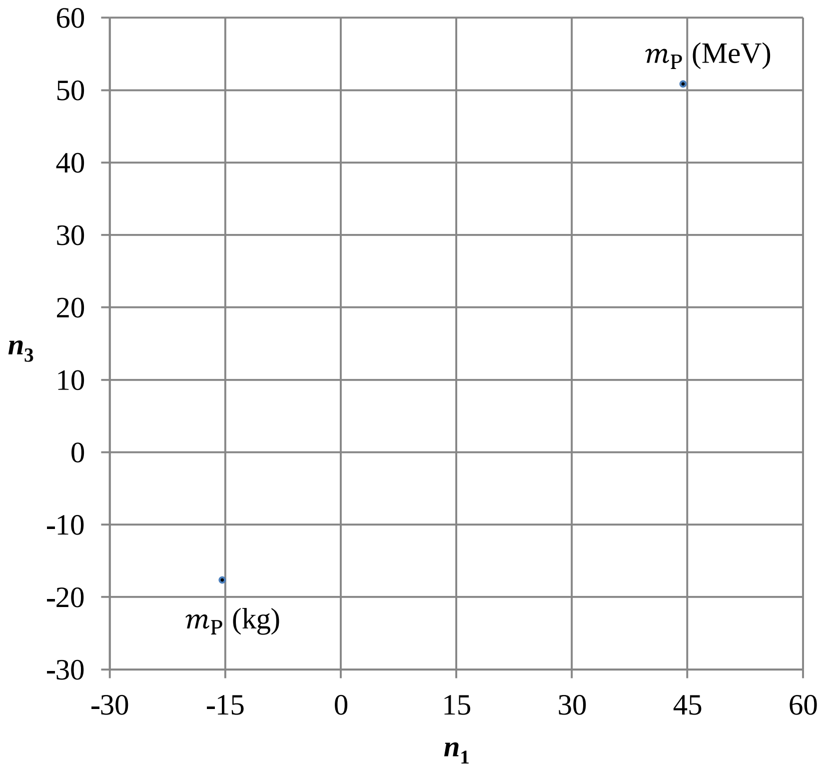

Figure 3: The Planck mass m_P as numbers of MeV and kilograms. Shown as powers n_1 and n_3 of π and e, respectively.

Using the evaluations of the Particle Data Group [5], here and generally in this paper, the masses of the W, Z and H^0 bosons as numbers of MeV lie close to principal levels in Sequences 1 and 2.

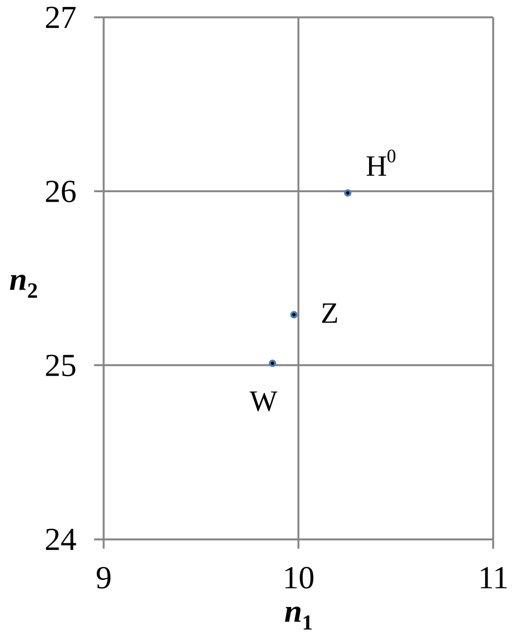

Figure 4: The masses of the W, Z and H^0 bosons as numbers of MeV. Shown as powers n_1 and n_2 of π and π/2, respectively. Mass of the W boson: 80.379(12) GeV; mass of the Z boson: 91.1976(21) GeV; mass of the H^0 boson: 125.10(14) GeV.

The masses of the light quarks (up, down and strange) as numbers of MeV, the units of the PDG evaluations, are shown on the principal levels and sub-levels of Sequences 1 and 3 in Figure 5. The masses of the up and down quarks are arranged symmetrically about Level 1 in Sequence 1. In MeV, $(\mathrm{m_u m_d})^{1/2} \approx \pi$. The strange quark lies close to Level 4 in Sequence 1.

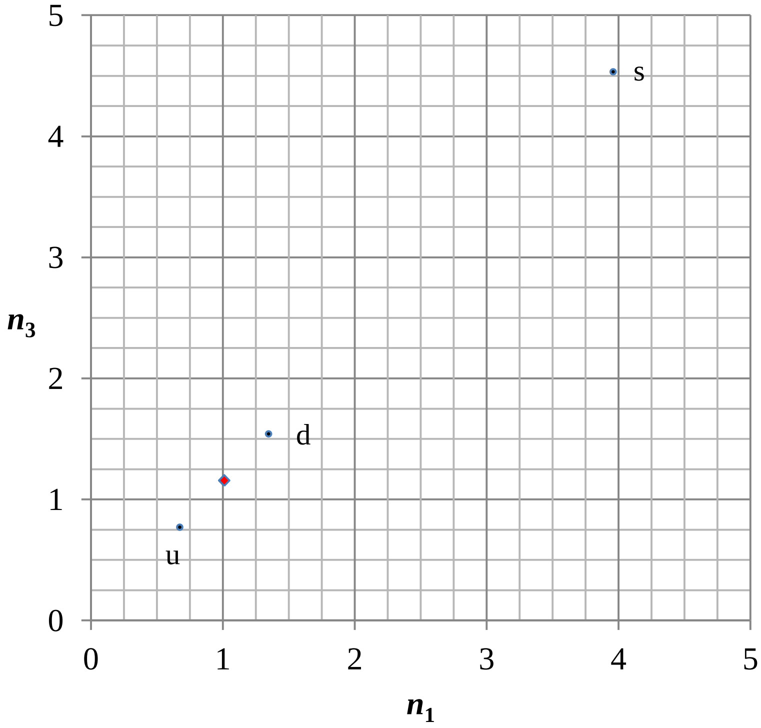

Figure 5: The masses of the up, down and strange quarks as numbers of MeV. Shown as powers n_1 and n_3 of π and e, respectively. The diamond is of mean n_1 and mean n_3 for the up and down quarks.

Mass of the up quark: 2.16 +0.49/-0.26 MeV

Mass of the down quark: 4.67 +0.48/-0.17 MeV

Mass of the strange quark: 93 +11/-5 MeV

The masses of the heavy quarks (charm, bottom and top) as numbers of GeV, the units of the PDG evaluations, are shown to lie on sub-levels of Sequences 1 and 3 in Figure 6.

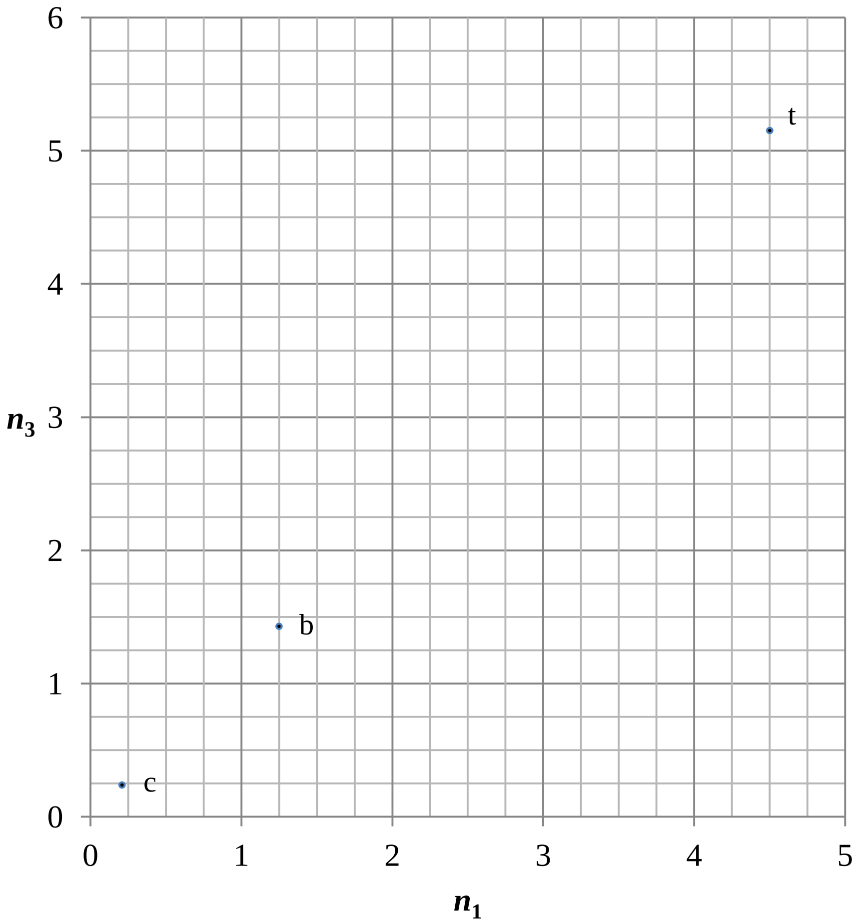

Figure 6: The masses of the charm, bottom and top quarks as numbers of GeV. Shown as powers n_1 and n_3 of π and e, respectively.

Mass of the charm quark: 1.27 +0.02/-0.02 GeV

Mass of the bottom quark: 4.18 +0.03/-0.02 GeV

Mass of the top quark: 172.9 +0.4/-0.4 GeV

The mass the electron as numbers of MeV (0.511) lies in near-symmetrical arrangement with the mass of the up quark as numbers of MeV (2.16) about the point (0, 0) in Sequences 1 and 3, as shown in Figure 7. In MeV, $(\mathrm{m_e m_u})^{1/2} \approx 1$. Also as shown in Figure 7, the masses of the muon and tau lepton, as numbers of MeV, lie in near-symmetrical arrangement about Level 6 in Sequence 3.

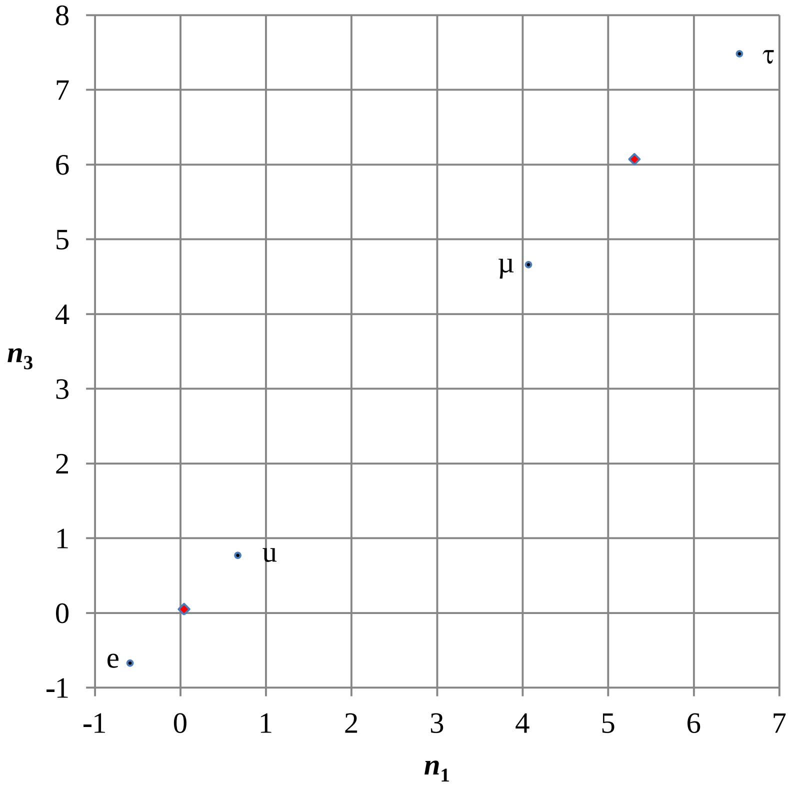

Figure 7: The masses of the electron, muon, tau lepton and up quark as numbers of MeV. Shown as powers n_1 and n_3 of π and e, respectively.

The 'reduced numbers' calculated for the muon and tau lepton lie in a beautiful symmetrical arrangement. Expressing the masses of the particles as numbers of MeV, the numbers are then reduced in size by the Quantum/Classical connection [6], actually a large number/small number correspondence, ${N_\mathrm{M}}^2 = 2{N_\mathrm{R}}^5$, where N_M is the measured large number and N_R is the corresponding small number. The measured numbers, 105.658 and 1776.86, map onto the reduced numbers 5.615 and 17.364, which are plotted on the levels of Sequences 1 and 2 in Figure 8. The two numbers lie in precise symmetrical arrangement about Level 2 in Sequence 1. As a result of the arrangement, in MeV, $\mathrm{m_\mu m_\tau} \approx 2\pi^{10}$.

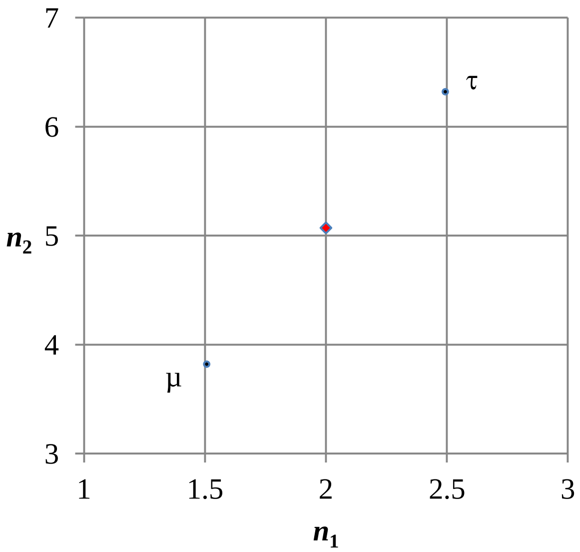

Figure 8: Reduced numbers calculated for the muon and tau lepton as numbers of MeV. Shown as powers n_1 and n_2 of π and $\pi/2$, respectively.

The muon and $\pi^{\pm}$ mesons, and the tau lepton and $D^{\pm}$ mesons, have previously been shown to form partnerships [1]. As numbers of MeV, the geometric mean value of the muon and $\pi^{\pm}$ meson masses and the geometric mean value of the tau lepton and $D^{\pm}$ meson masses lie on sub-levels of level-number 10.625 and 16.625 in Sequence 2, as shown in Figure 9.

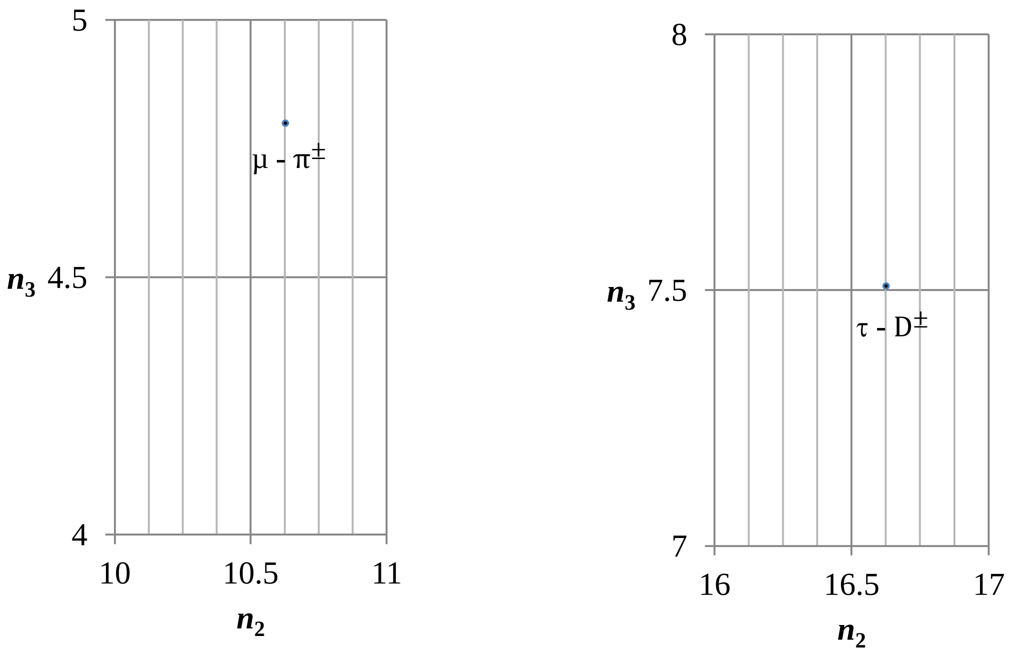

Figure 9: The geometric mean values as numbers of MeV of the muon and $\pi^{\pm}$ meson masses, and of the tau lepton and $D^{\pm}$ meson masses. Shown as powers n_2 and n_3 of $\pi/2$ and e, respectively.

As numbers of MeV, the charged lepton-meson mass differences lie close to a principal level and half-levels in Sequences 2 and 3, as shown in Figure 10.

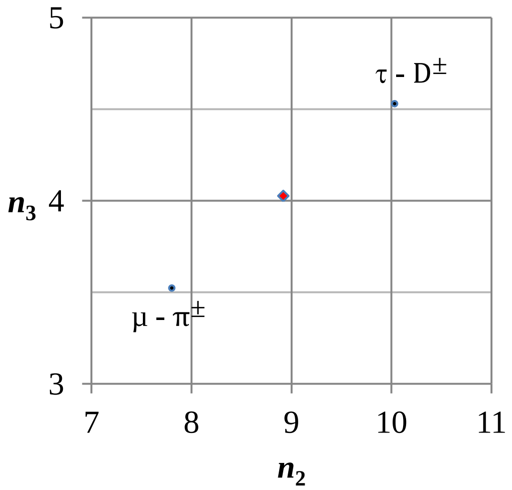

Figure 10: The mass differences of the muon and $\pi^{\pm}$ mesons (33.91 MeV), and of the tau lepton and $D^{\pm}$ mesons (92.79 MeV) as numbers of MeV. Shown as powers n_2 and n_3 of $\pi/2$ and e, respectively. The diamond marks the point of mean n_2 and mean n_3.

Finally, on particles, as numbers of MeV the masses of the $I(J^P) = 0(0^-)$ mesons η (547.862(17) MeV), η' (957.78(6) MeV), η_c (2983.9(5) MeV) and η_b (9398.7(2.0) MeV) assume a pleasing arrangement in Sequences 1 and 2, as shown in Figure 11.

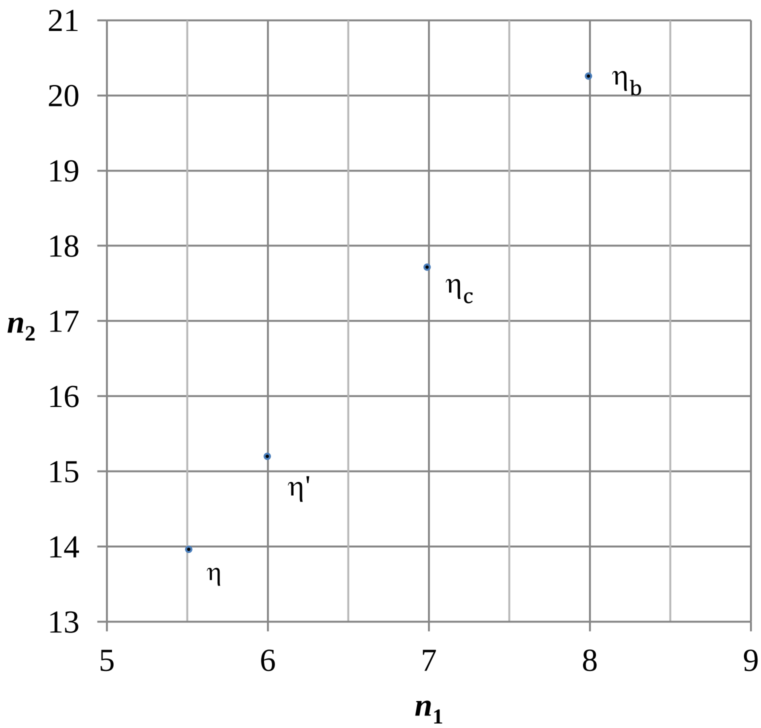

Figure 11: The masses of the η, η', η_c and η_b mesons as numbers of MeV. Shown as powers n_1 and n_2 of π and π/2, respectively.

As numbers of metres, various prominent astronomical distances lie close to principal levels and sub-levels in the number sequences. The mean distance of the Moon from Earth, the mean distance of the Earth from the Sun, the light-year, the distance of the Andromeda Galaxy from Earth and the Hubble length are shown on the levels and sub-levels of Sequences 1 and 3 in Figure 12. The distances of the bodies and objects here lie close to superlevels.

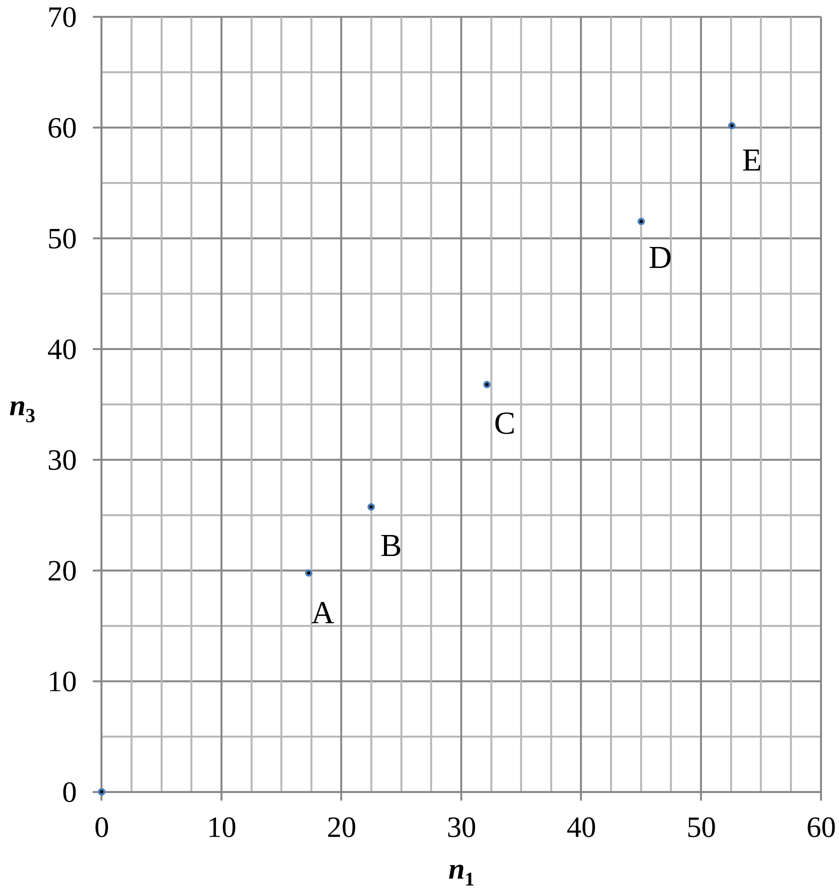

Figure 12: Astronomical and cosmological distances as numbers of metres and shown as powers n_1 and n_3 of π and e, respectively.

A Semi-major axis of the Moon's orbit, 3.844×10^{8} m [7]

B Semi-major axis of the Earth's orbit, 1.496×10^{11} m [7]

C Light-year, 9.461×10^{15} m

D Distance from Earth of the Andromeda Galaxy (M31), 2.365×10^{22} m (2.5×10^{6} lyr)

E Hubble length, 1.353×10^{26} m (14.3×10^{9} lyr)

As numbers of kilograms, the masses of prominent astronomical bodies and objects lie close to principal levels and sub-levels in the number sequences. The masses of the Moon, Earth, Jupiter, Sun, Sagittarius A* (the supermassive black hole in the centre of the Milky Way Galaxy), Milky Way Galaxy and Hubble Volume are shown on the levels and sub-levels of Sequences 1 and 3 in Figure 13. The masses of the bodies and objects here, other than the Moon, lie close to superlevels.

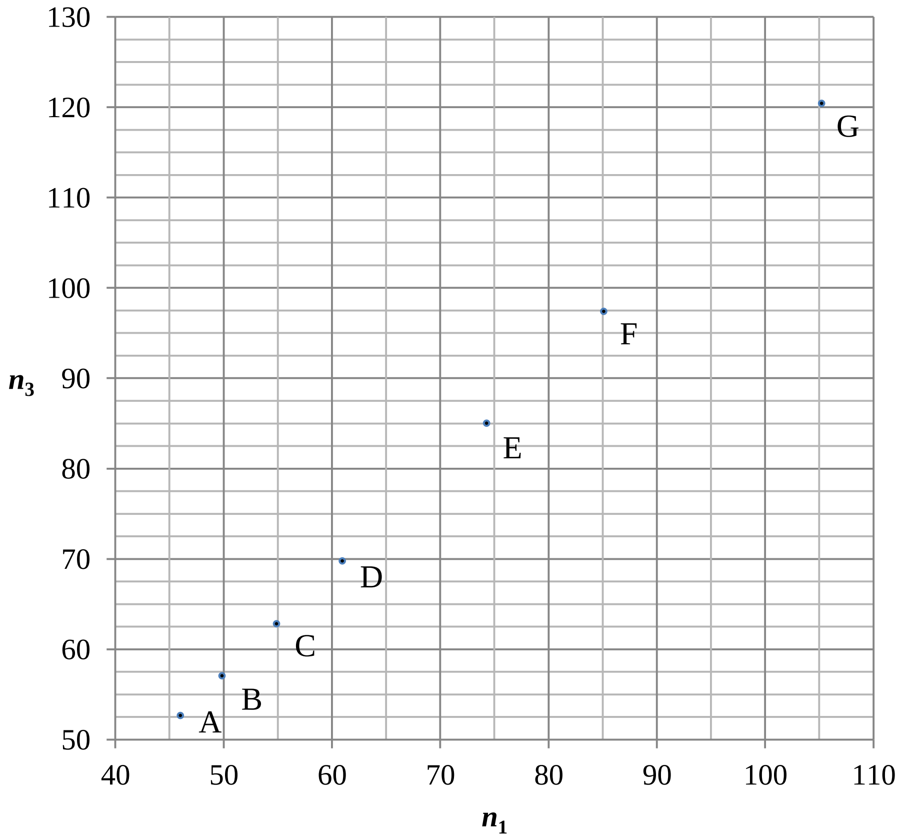

Figure 13: Astronomical and cosmological masses as numbers of kilograms and shown as powers n_1 and n_3 of π and e, respectively

A Mass of the Moon, 7.346×10^{22} kg [7]
B Mass of the Earth, 5.972×10^{24} kg [7]
C Mass of Jupiter, 1.898×10^{27} kg [7]
D Mass of the Sun, 1.989×10^{30} kg [7]
E Mass of Sagittarius A*, 8.35×10^{36} kg ($4.2\times10^{6}\,M_{\odot}$)
F Mass of the Milky Way Galaxy, 2×10^{42} kg (~ $10^{12}\,M_{\odot}$)
G Mass of the Hubble Volume, ~ 2×10^{52} kg

As numbers of Kelvin, the triple points, normal boiling points and critical temperatures of hydrogen, helium and oxygen lie close to principal levels and sub-levels in Sequences 1 and 3, as shown in Figure 14.

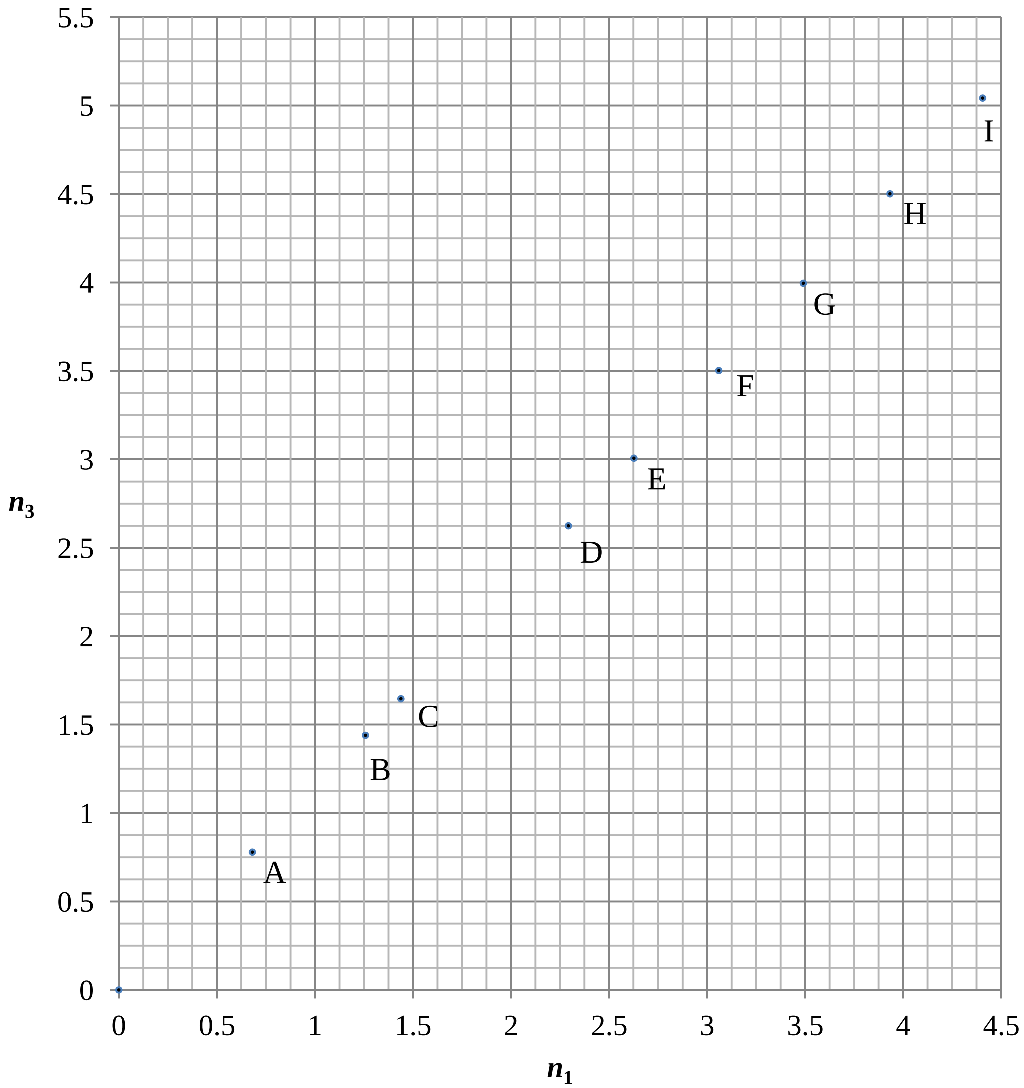

Figure 14: Characteristic temperatures of three cryogens as numbers of Kelvin and shown as powers n_1 and n_3 of π and e, respectively.

A	Helium: triple point 2.18 K
B	Helium: normal boiling point 4.22 K
C	Helium: critical point 5.19 K
D	Hydrogen: triple point 13.8 K
E	Hydrogen: normal boiling point 20.3 K
F	Hydrogen: critical point 33.2 K
G	Oxygen: triple point 54.4 K
H	Oxygen: normal boiling point 90.2 K
I	Oxygen: critical point 155 K

The temperature of the cosmic microwave background at recombination (~ 3000 K) and the current temperature (2.725 K) as numbers of Kelvin are shown as powers of π and e in Figure 15.

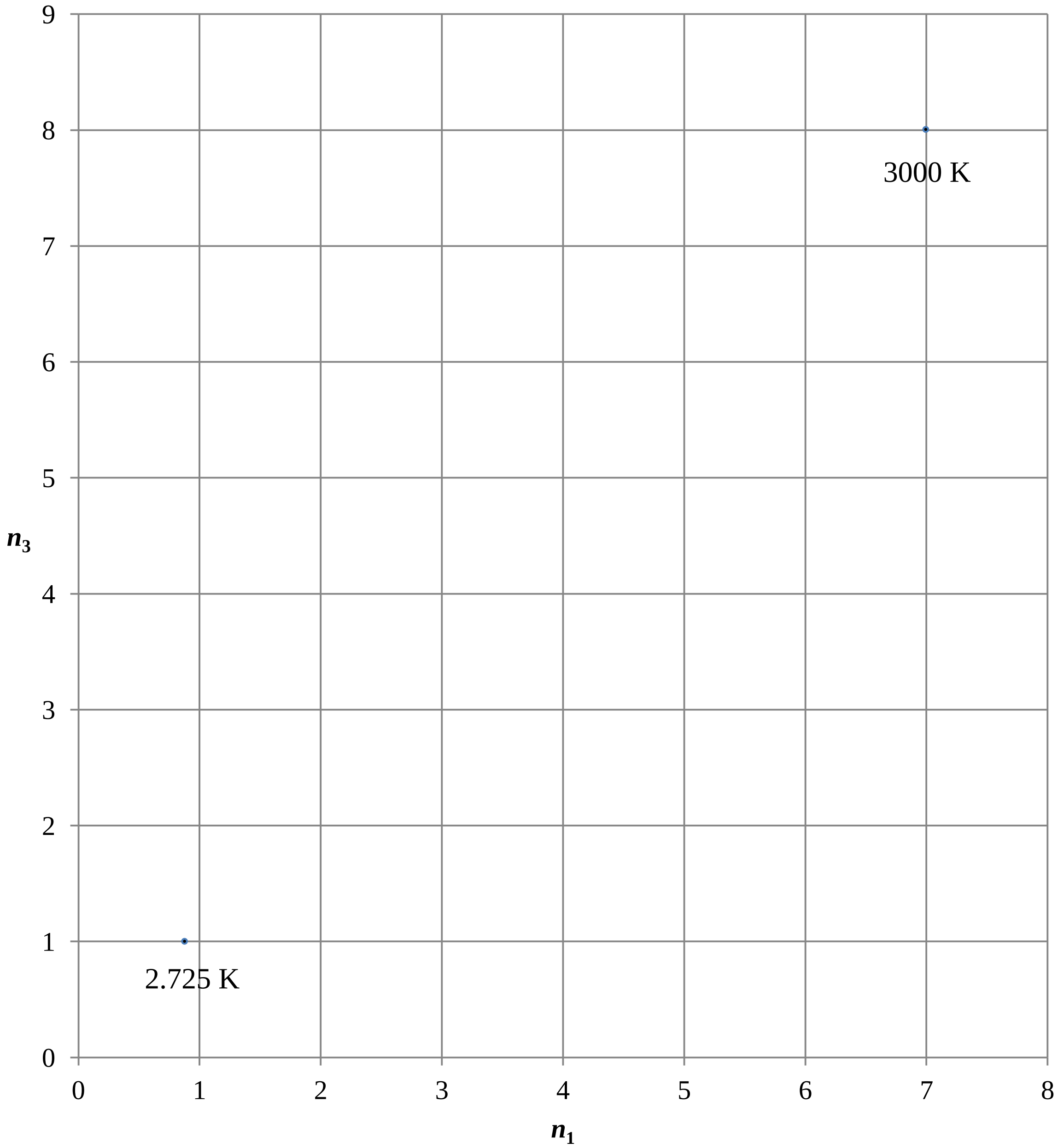

Figure 15: CMB temperatures of 3000 K at recombination and 2.725 K currently, as numbers of Kelvin and shown as powers n_1 and n_3 of π and e, respectively

An interesting point arises in a consideration of the Hubble tension: the discrepancy between the value of the Hubble constant H_0 found from observations of the CMB (67.4 ± 0.5 km.s^{-1}Mpc^{-1} [8]) and the value found from observations of supernovae and cepheids (73.2 ± 1.3 km.s^{-1}Mpc^{-1} [9]). As numbers of km.s^{-1}Mpc^{-1} the two values of Hubble constant are shown as powers of π and π/2 in Figure 16; the 'reduced numbers' (4.848 and 4.691) are shown as powers of π and π/2 in Figure 17.

We see that both the measured and reduced numbers for H_0 = 73.2 km.s^{-1}Mpc^{-1} lie at the 'intersection' of 'low-order' sub-levels in Sequences 1 and 2. Such locations are often occupied by the measurement values of conspicuous parameters. Finding the number 73.2 on the intersections perhaps reflects the expectation of the observer.

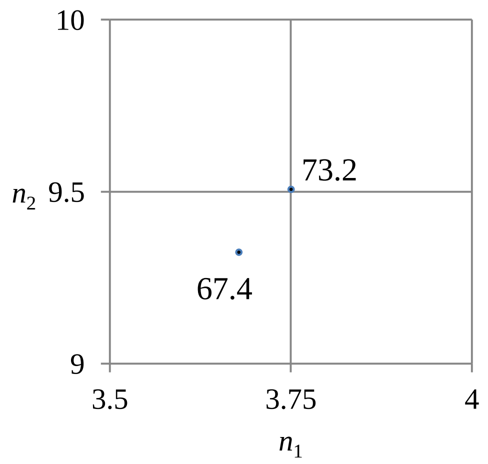

Figure 16: Two values of the Hubble constant H_0 as numbers of km.s^{-1}Mpc^{-1} and shown as powers n_1 and n_2 of π and π/2, respectively.

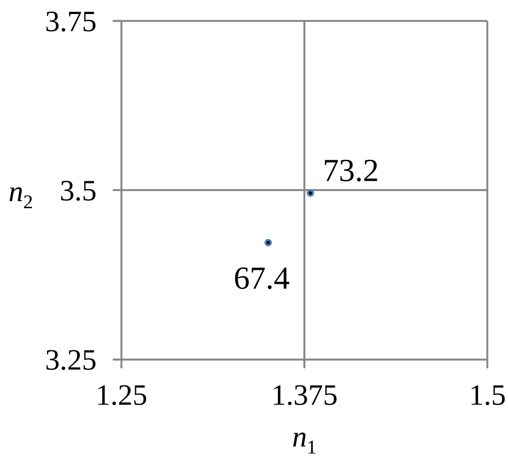

Figure 17: Reduced numbers (4.848 and 4.691) calculated for two values of the Hubble constant H_0 as numbers of km.s^{-1}Mpc^{-1} and shown as powers n_1 and n_2 of π and π/2, respectively.

In conclusion, there are no natural units of measurement. We choose the units of our measurements based on our experience of the world and everything we measure is compared in size to our units through multiplication by numbers equal to integer, half-integer, quarter-integer, etc powers of π, $\pi/2$ and e. There is a natural geometry (of spacetime) in which the numbers are stored.

We can use SI units for the results of our measurements but it may be convenient to use other units, for example MeV. We can even use Planck units. For dimensionless quantities we might use the unit one but we could choose the unit to be a hundred or a million. No matter what our choice of unit, the measurement outcome must be consistent with all preceding measurement outcomes.

References

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