Half-Lives and the Planck Time

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If the value of a half-life is expressed in numbers of Planck times and that number is converted to a smaller 'reduced number' by application of the Quantum/Classical connection - a power-law equation - then the reduced number will be an integer power or a specific fractional power of π and of e. Integer powers of either π or e are found for the half-lives of the W boson, the Higgs boson, the muon and the tau lepton. The reduced numbers of many notable radionuclides are equal to integer, half-integer and quarter-integer powers of π and/or of e.

1 Introduction

The Quantum/Classical connection, which was found in an analysis of vacuum energy, relates, in Planck units, parameters of small value in the quantum realm, and parameters of large value in the classical realm [1, 2]. Essentially a connection between small and large numbers [3], the Quantum/Classical connection may be written as

$$2{N_{\mathrm{R}}}^5 = {N_{\mathrm{L}}}^2 \tag{1}$$

where N_{L} is a measured large number and N_{R} is a corresponding 'reduced' number. Here, N_{L} is the value of a half-life in numbers of Planck times and N_{R} is a pure number. The value of Planck time used in the calculations is $5.391247(60)\times10^{-44}$ s [4].

Values of reduced number N_{R} calculated from measured values N_{L} of half-life are shown to be equal to integer and fractional (half-integer, quarter-integer and eighth-integer) powers of π, π/2 and e: the three bases may derive from the geometry of a higher-dimensional spacetime [5]. Expressing values of N_{R} as powers n_1, n_2 and n_3 of π, π/2 and e, respectively, the reduced numbers lie on 'principal' levels of integer level-number and 'sub-levels' of half-integer, quarter-integer and eighth-integer level-number in three geometric sequences that ascend from unity: Sequence 1 of common ratio π, Sequence 2 of common ratio π/2 and Sequence 3 of common ratio e. Sequence 2 features only briefly here. Levels in Sequences 1, 2 and 3 are numbered n_1, n_2 and n_3, respectively. The level-numbers are plotted one against another, the markers lying on a straight line since the level-numbers in the three sequences are in constant ratio.

2 The W, Z and Higgs Bosons

The decay width of the W boson is 2.085(42) GeV [6]. The mean life τ_W of the boson is given by $\tau_W = \hbar/\Gamma$, where $\hbar = 6.582\times10^{-22}$ MeV.s and Γ is the decay width in MeV. The half-life is then given by $t_{½} = \tau_W ln(2)$, resulting in a value of 2.188×10^{-25} s, for which $N_{\mathrm{L}} = 4.059\times10^{18}$ and $N_{\mathrm{R}} = 2.416\times10^{7}$. The value of n_3 is given by $ln(N_{\mathrm{R}})$, which equals 17.00.

The decay width of the Z boson is 2.4952(23) GeV [6]. The half-life is then 1.829×10^{-25} s, for which $N_{\mathrm{L}} = 3.392\times10^{18}$ and $N_{\mathrm{R}} = 2.249\times10^{7}$. The value of n_2 is given by $ln(N_{\mathrm{R}})/ln(\pi/2)$, which equals 37.49.

The decay width of the Higgs boson is ~4.1 MeV [7], which corresponds to a half-life of 1.11×10^{-22} s. It follows that $n_1 = 17.03$ and $n_3 = 19.49$.

The reduced numbers N_{R} calculated from the half-lives of the W boson and the Higgs boson are shown as powers n_1 and n_3 of π and e, respectively, in Figure 1.

The reduced numbers N_{R} calculated from the half-lives of the W, Z and Higgs bosons are shown as powers n_2 and n_3 of $\pi/2$ and e, respectively, in Figure 2.

The reduced number calculated from the half-life of the Higgs boson lies at the 'intersection' of a principal level and a half-level, (17, 19.5), in Sequences 1 and 3. 'Low-order' intersections such as this are typically occupied by reduced numbers calculated from the parameters of conspicuous objects [8]. The reduced numbers calculated from the half-lives of the W and Z bosons lie at the near-intersection (37.5, 17) in Sequences 2 and 3. Level-numbers in Sequence 2 that are multiples of 12.5 (being equal to 25 divided by 2) are important locations for physics [9]. The masses of the W and Z bosons are arranged about Level 87.5 in Mass Sequence 2 at the near-coincidence (87.5, 40) in Mass Sequences 2 and 3, which descend from the Planck mass with common ratio $2/\pi$ and $1/e$ [9].

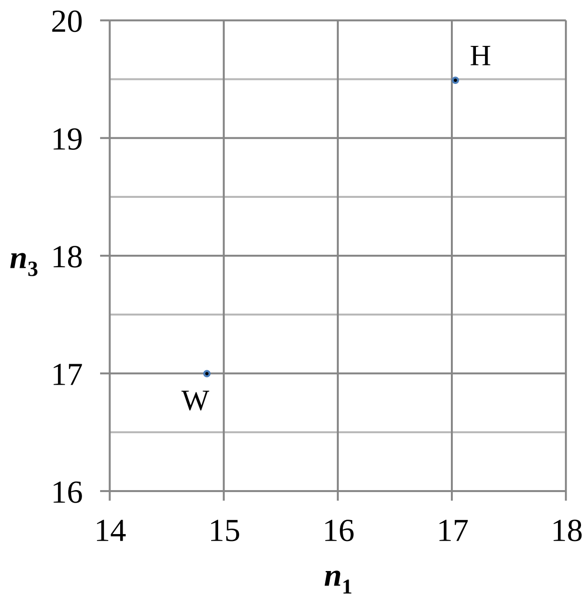

Figure 1: Reduced numbers N_{R} derived from the half-lives of the W and Higgs bosons as powers n_1 and n_3, respectively, of π and e.

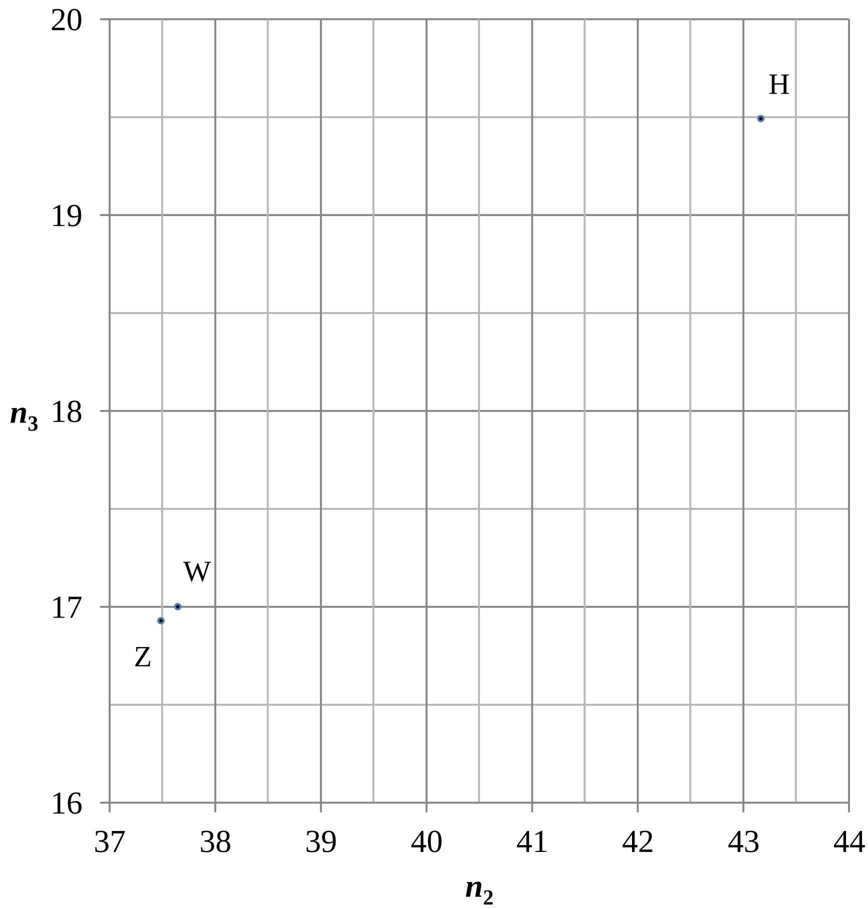

Figure 2: Reduced numbers N_R derived from the half-lives of the W, Z and Higgs bosons as powers n_2 and n_3, respectively, of π/2 and e.

3 The Muon and the Tau Lepton

The mean lives of the muon and tau lepton are 2.1969811(22)×10^{-6} s and 290.3(5)×10^{-15} s, respectively [6]. The muon half-life is then 1.5228×10^{-6} s, for which $n_1 = 30.01$. The tau lepton half-life is 201.2×10^{-15} s, for which $n_3 = 28.02$.

The reduced numbers N_R calculated from the half-lives of the muon and the tau lepton are shown as powers n_1 and n_3 of π and e, respectively, in Figure 3.

Both reduced numbers lie on principal levels.

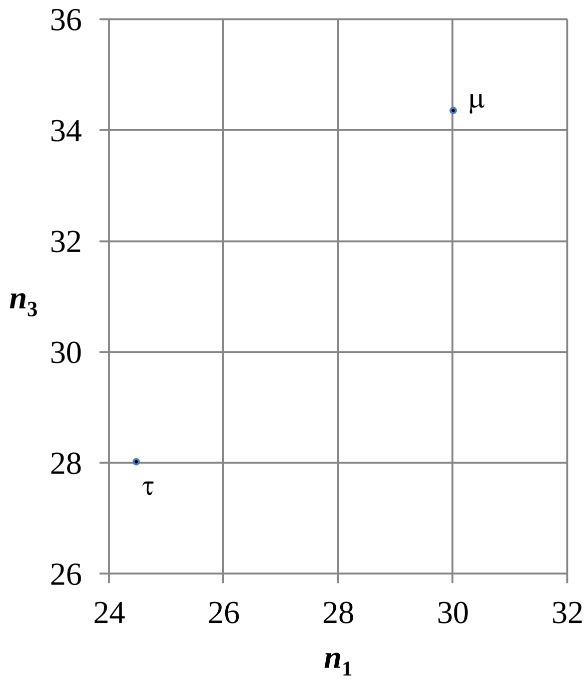

Figure 3: Reduced numbers N_R derived from the half-lives of the muon (μ) and tau lepton (τ) as powers n_1 and n_3, respectively, of π and e.

4 Radionuclides Associated with Nuclear Energy

The half-lives of five important long-lived radionuclides are presented in Table 1. The reduced numbers N_R calculated from the half-lives of the nuclides are shown as powers n_1 and n_3 of π and e, respectively, in Figure 4.

Nuclide	Half-life (years) [10]	Comments
^{238}U	$4.468(6)\times10^9$	Constitutes >99% of natural uranium
^{235}U	$7.04(1)\times10^8$	Fissile
^{129}I	$1.57(4)\times10^7$	Fission product; disproportionate biohazard
^{99}Tc	$2.111(12)\times10^5$	Major fission product
^{239}Pu	$2.411(3)\times10^4$	Fissile

Table 1: Half-lives of radionuclides associated with nuclear energy

One reduced number (that of ^{99}Tc) lies at the intersection of a principal level and a half-level, while another (that of ^{238}U) lies at the intersection of two half-levels and another (that of ^{129}I) lies at the intersection of a half-level and a quarter-level. Again, we see that principal levels and low-order sub-levels and their intersections are locations for the reduced numbers calculated from the parameters of the most conspicuous objects.

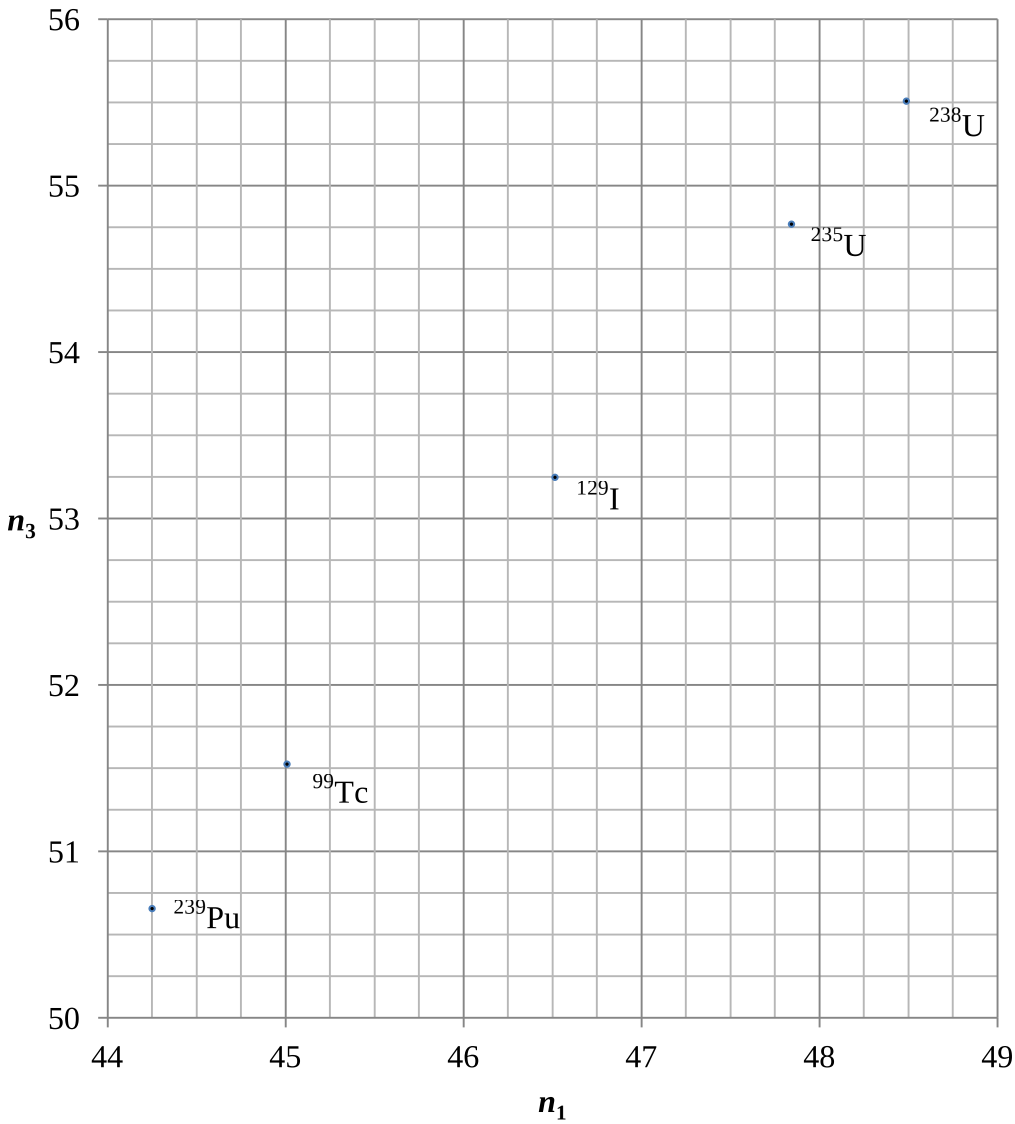

Figure 4: Reduced numbers N_R derived from the half-lives of five radionuclides associated with nuclear energy**,** as powers n_1 and n_3, respectively, of π and e.

5 Three notable radionuclides

The half-lives of three notable radionuclides are presented in Table 2. The reduced numbers N_R calculated from the half-lives of the nuclides are shown as powers n_1 and n_3 of π and e, respectively, in Figure 5.

Nuclide	Half-life (years) [10]	Comments
^{14}C	5700(30)	Basis of radiocarbon dating
^{3}H	12.32(2)	Fusion reactor fuel; radioactive tracer
^{252}Cf	2.645(8)	Strong neutron source

Table 2: Half-lives of three notable radionuclides

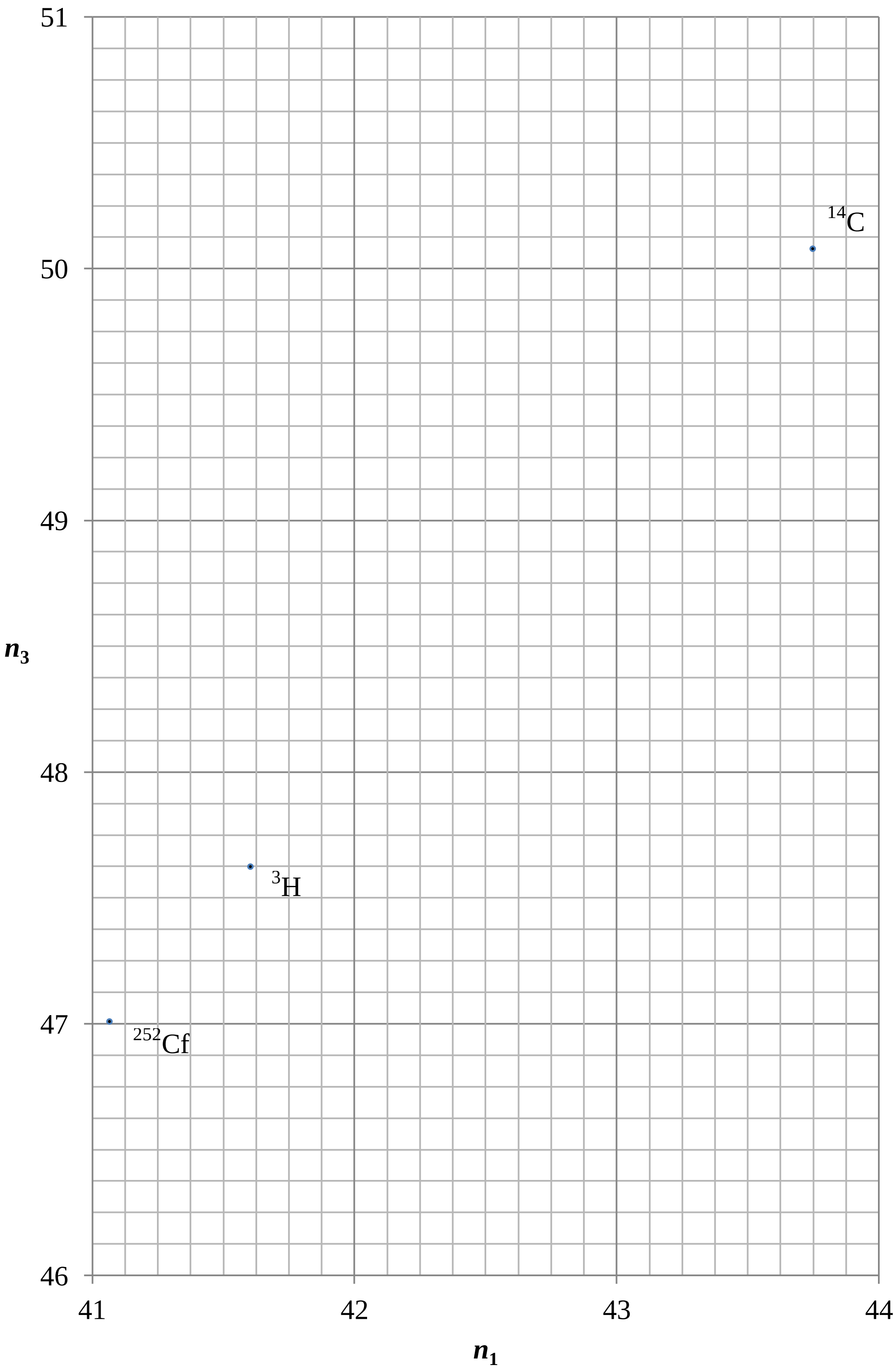

Figure 5: Reduced numbers N_R derived from the half-lives of three notable radionuclides**,** as powers n_1 and n_3, respectively, of π and e.

Principal level and sub-level occupation by N_R again results.

6 Extinct Radionuclides

Studies of meteorites have shown that now extinct radionuclides, including ^{41}Ca, ^{26}Al, ^{60}Fe, ^{53}Mn and ^{182}Hf, resulting from supernova explosions, were present during the early stages of formation of the solar system. For a review of the meteorite studies see the introduction in [11]. The half-lives of the above five nuclides are presented in Table 3.

Nuclide	Half-life (years) [10]
^{41}Ca	$9.94(15)\times10^{4}$
^{26}Al	$7.17(24)\times10^{5}$
^{60}Fe	$2.62(4)\times10^{6}$
^{53}Mn	$3.74(4)\times10^{6}$
^{182}Hf	$8.90(9)\times10^{6}$

Table 3: Half-lives of five radionuclides resulting from supernova explosions

The reduced numbers N_{R} calculated from the half-lives of the nuclides are shown as powers n_1 and n_3 of π and e, respectively, in Figure 6.

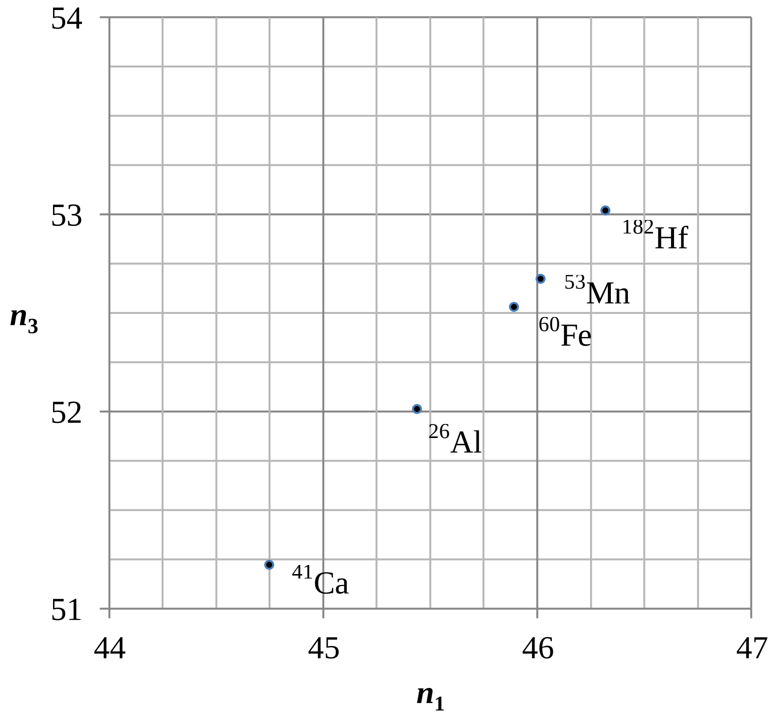

Figure 6: Reduced numbers N_{R} derived from the half-lives of five radionuclides resulting from supernova explosions**,** as powers n_1 and n_3, respectively, of π and e. The marker size is an indication of the uncertainty in location.

Three of the five reduced numbers lie on principal levels.

7 Conclusions

By way of the Quantum/Classical connection, half-lives measured in numbers of Planck times are converted to reduced numbers that are equal to integer and specific fractional powers of π, π/2 and e. The half-lives of many conspicuous particles and nuclides result in reduced numbers equal to integer, half-integer and quarter-integer powers of π, π/2 and e.

8 References

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