Planets and their Moons as Trans-Planckian Bodies

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The 10D/4D correspondence between subatomic particle mass scales and cosmological length scales has been extended to relate trans-Planckian length scales and astrophysical mass scales. In addition to the black holes previously described, the planets and moons of the Solar System have now been found to occupy levels of trans-Planckian length scale within three geometric sequences that derive from the geometry of spacetime. The planets lie in a symmetric arrangement of four twinned pairs on the levels. Exoplanetary systems are also symmetrically arranged. Planetary systems are related in mass to their star through a gravitational coupling constant incorporated within the trans-Planckian scheme.

1 Introduction

The masses of specific black holes correspond to conspicuous ten-dimensional trans-Planckian length scales within a network of levels that is tied to Planck scale and mirrors the network of mass levels within which subatomic particles lie [1]. The levels derive from the geometry of spacetime [2]. Supermassive black holes are analogous to atomic nuclei on the opposite side of the Planck divide. The galaxy cluster, the most massive gravitationally bound object in the universe, occupies a special location within the trans-Planckian network, suggesting that gravitationally bound objects in general are of trans-Planckian nature. As their masses are unchanging and known with some precision, a study has been made of the trans-Planckian nature of the planets and moons of the Solar System. Building on the results of that study, the trans-Planckian nature of several exoplanetary systems has been investigated.

2 The Model

The 10D/4D correspondence relates subatomic particle mass scales and cosmological length scales:

$$2{m_{1,10}}^{-5} = {l_{1,4}}^{2} \tag{1}$$

where $m_1 < m_{Planck}$ and $l_1 > l_{Planck}$ [3, 4]. The subscripts 10 and 4 refer to the dimensions of the respective spacetimes of the model. A second 10D/4D correspondence:

$$2{l_{2,10}}^{-5} = {m_{2,4}}^{2} \tag{2}$$

formulated on trans-Planckian scales ($l_2 < l_{Planck}$, $m_2 > m_{Planck}$) relates length scales and astrophysical mass scales [1]. We will make use of (2) to calculate the values of trans-Planckian length scale ($l_{2,10}$) corresponding to the masses ($m_{2,4}$) of celestial bodies.

On cis-Planckian scales ($m < m_{Planck}$, $l > l_{Planck}$) the masses of subatomic particles lie within three sequences of levels that descend from the Planck Mass: Sequence 1 of common ratio $1/\pi$, Sequence 2 of common ratio $2/\pi$ and Sequence 3 of common ratio 1/e [2, 5]. Levels in the three sequences are numbered n_1, n_2 and n_3 sequentially from Planck scale ($n = 0$). Trans-Planckian length scales descend from the Planck Length within sequences of common ratio $1/\pi$, $2/\pi$ and 1/e. Levels in the three trans-Planckian sequences are numbered ν_1, ν_2 and ν_3 sequentially from Planck scale ($\nu = 0$).

3 The Solar System

Jupiter, the largest planet in the Solar System, occupies a principal (integer level-number) trans-Planckian level in Sequence 1, at the level-coincidence (28, 71, 32) in Sequences 1, 2 and 3, as shown in Figure 1. Such close coincidences are rare. The Earth and Moon occupy principal levels in Sequence 1 (Earth) and Sequences 2 and 3 (Moon), as shown in Figure 2. The Earth lies adjacent to the level-coincidence (26, 66) in Sequences 1 and 2, while the Moon lies on (62, 28) in Sequences 2 and 3. Data on the planets and moons of the Solar System have been taken from the NASA Space Science Data Coordinated Archive [6].

For the moment, we will concentrate on the planets of the Solar System, returning to the moons later in this section.

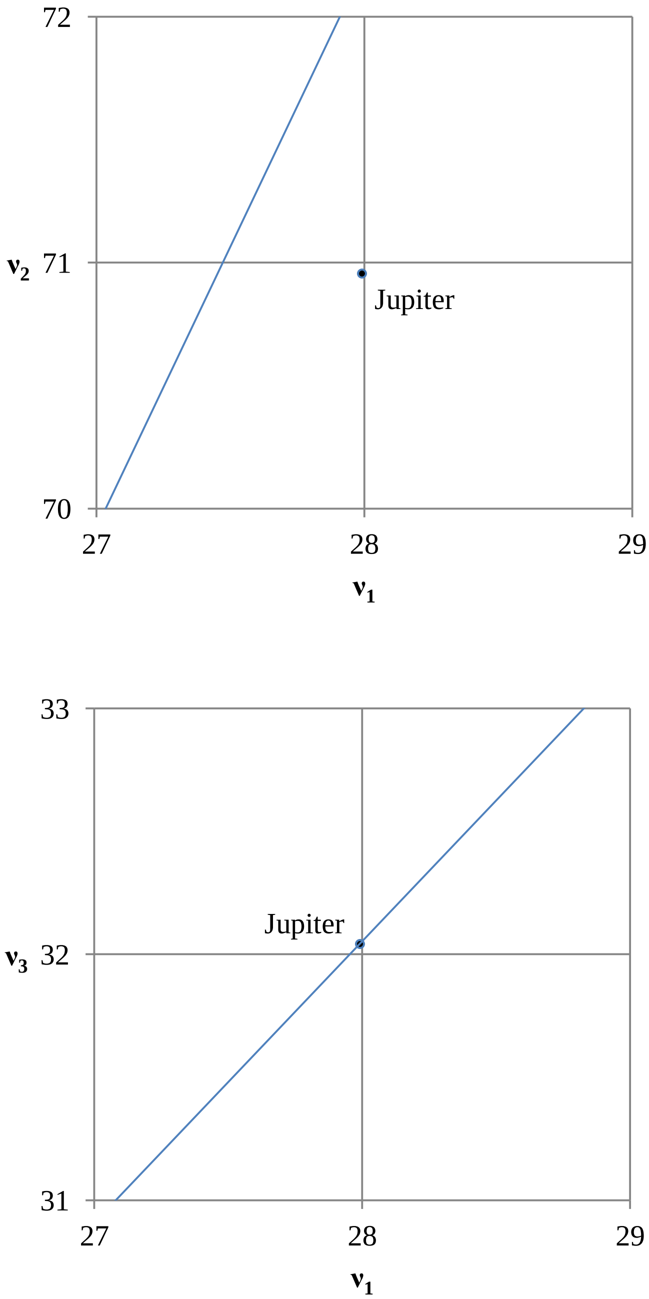


Figure 1: Jupiter on the trans-Planckian levels of Sequences 1, 2 and 3. Length scales are constrained to lie on the blue line since for any scale the corresponding level-numbers in Sequences 1, 2 and 3 are in constant ratio.

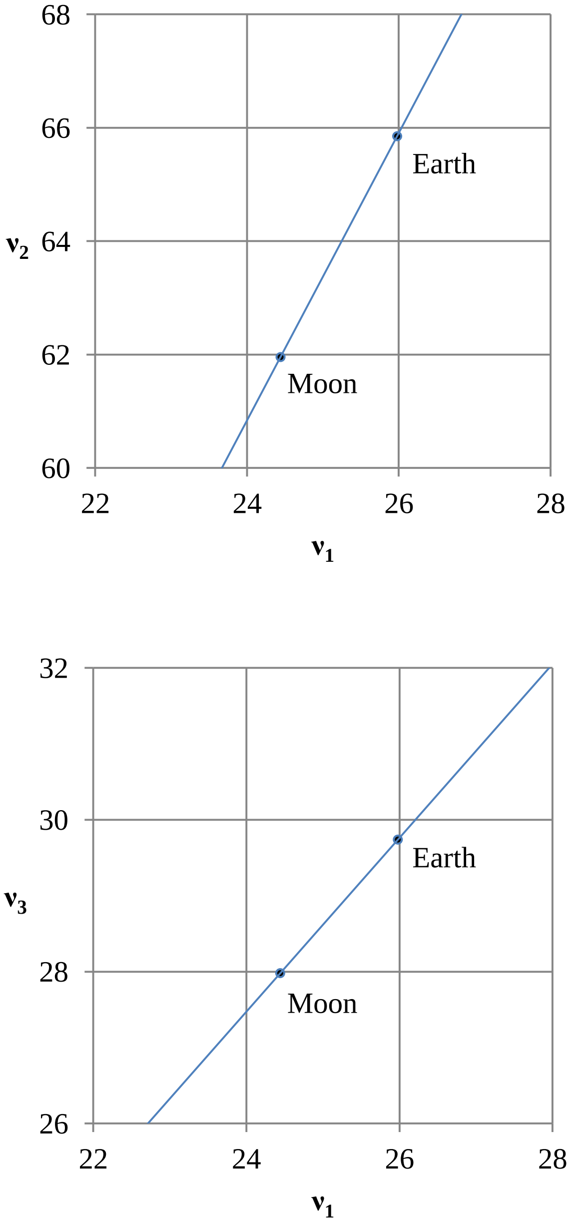


Figure 2: Earth and Moon on the trans-Planckian levels of Sequences 1, 2 and 3.

Four planets (Jupiter, Neptune, Earth and Mercury) lie on or close to consecutive principal trans-Planckian levels in Sequence 1, as shown in Figure 3. Mercury actually occupies a sublevel, as shown in Figure 4, in which Mars is also shown to occupy a sublevel. Saturn also occupies a sublevel, as shown in Figure 5. The twin planets Earth and Venus, and the twins Neptune and Uranus, are arranged about sublevels, as shown in Figure 6, in the manner of isospin doublets on the cis-Planckian mass levels [7]. The two planetary doublets are arranged symmetrically about Level 67 in Sequence 2. The eight planets of the Solar System are shown on the trans-Planckian levels of Sequences 1 and 2 in Figure 7.

Pursuing the hypothesis that the planets comprise four pairs of twins (Mars – Mercury, Earth – Venus, Jupiter – Saturn and Neptune – Uranus), the geometric mean of the two planetary masses has been calculated for each pair and the corresponding length scale plotted on the trans-Planckian levels of Sequences 2 and 3 in Figure 8. The pairs are arranged symmetrically about Level 67 in Sequence 2. The arrangement brings to mind the symmetrical arrangement of the quarks, in doublets, on the cis-Planckian mass levels of Sequences 2 and 3 [5].

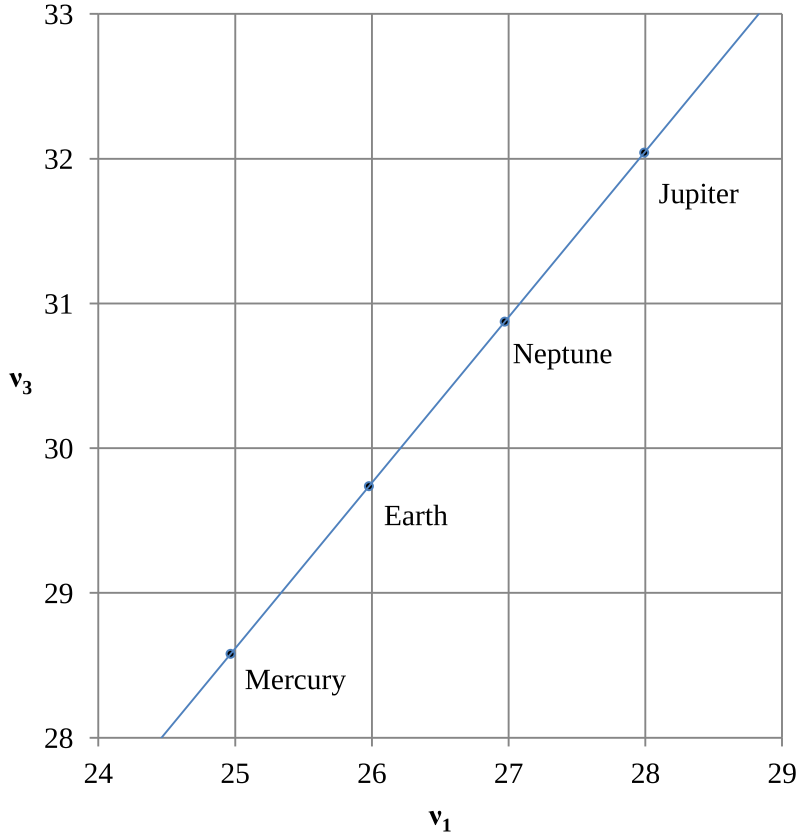


Figure 3: Planets on the trans-Planckian levels of Sequences 1 and 3.

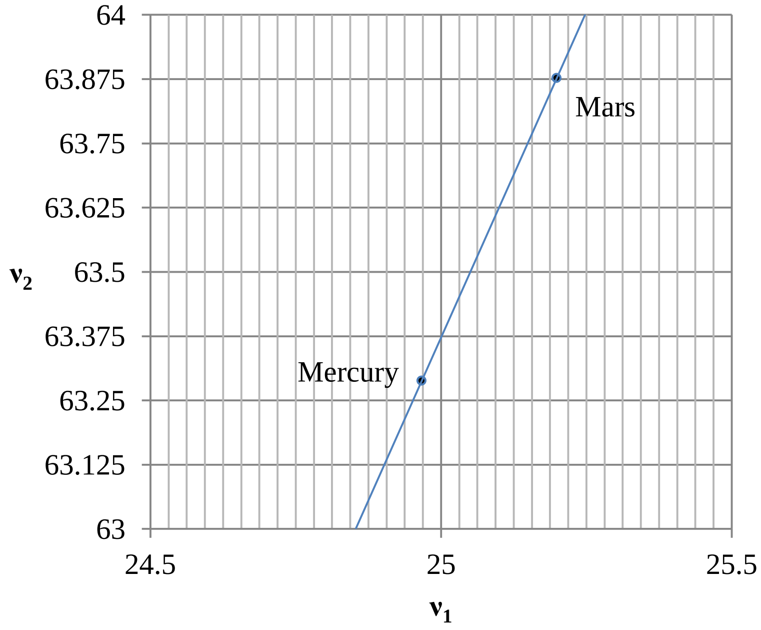


Figure 4: Mars and Mercury on the trans-Planckian levels and sublevels of Sequences 1 and 2.

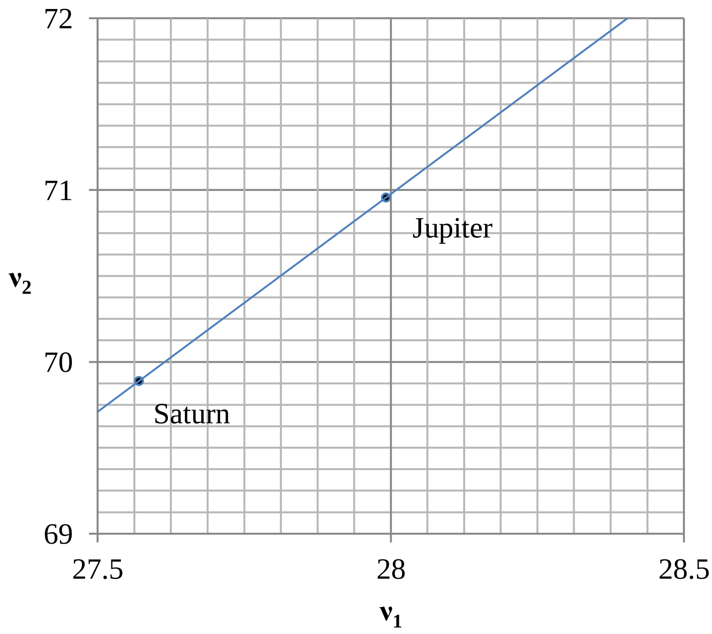


Figure 5: Jupiter and Saturn on the trans-Planckian levels and sublevels of Sequences 1 and 2.

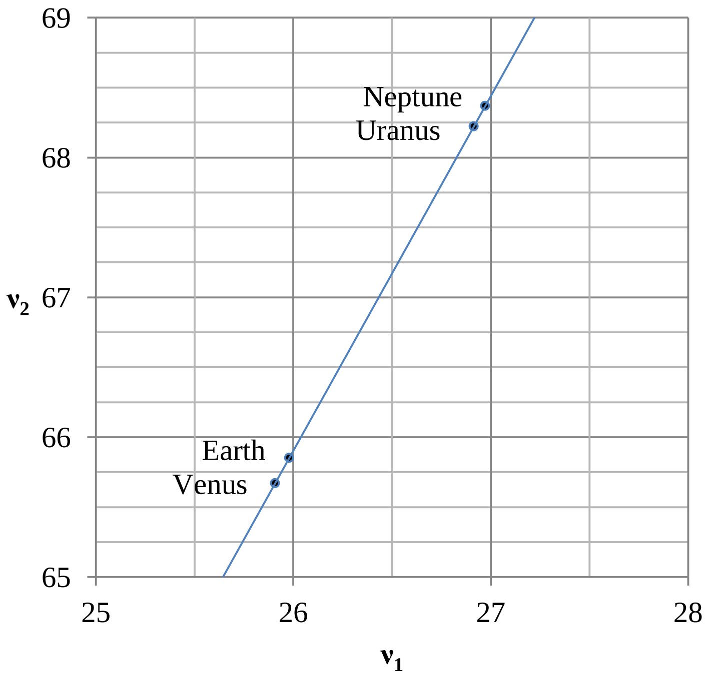


Figure 6: The twin planets Earth and Venus, and the twins Neptune and Uranus, on the trans-Planckian levels and sublevels of Sequences 1 and 2.

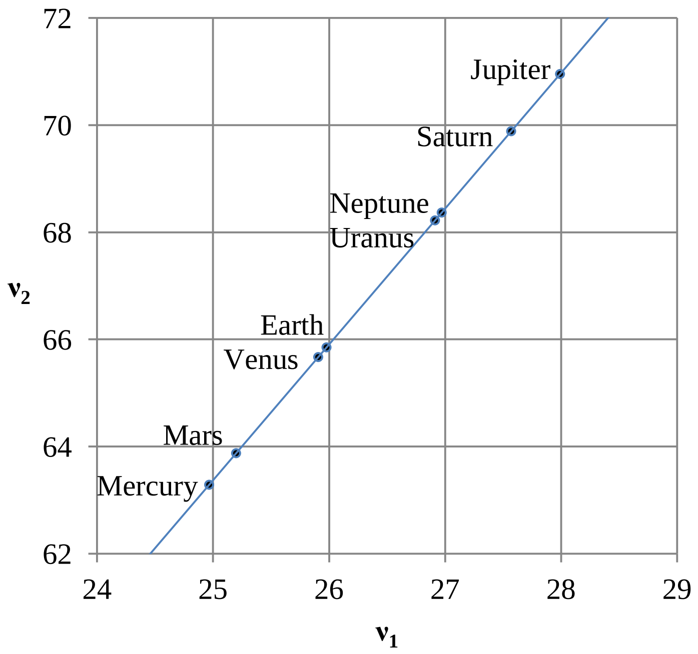


Figure 7: The planets of the Solar System on the trans-Planckian levels of Sequences 1 and 2.

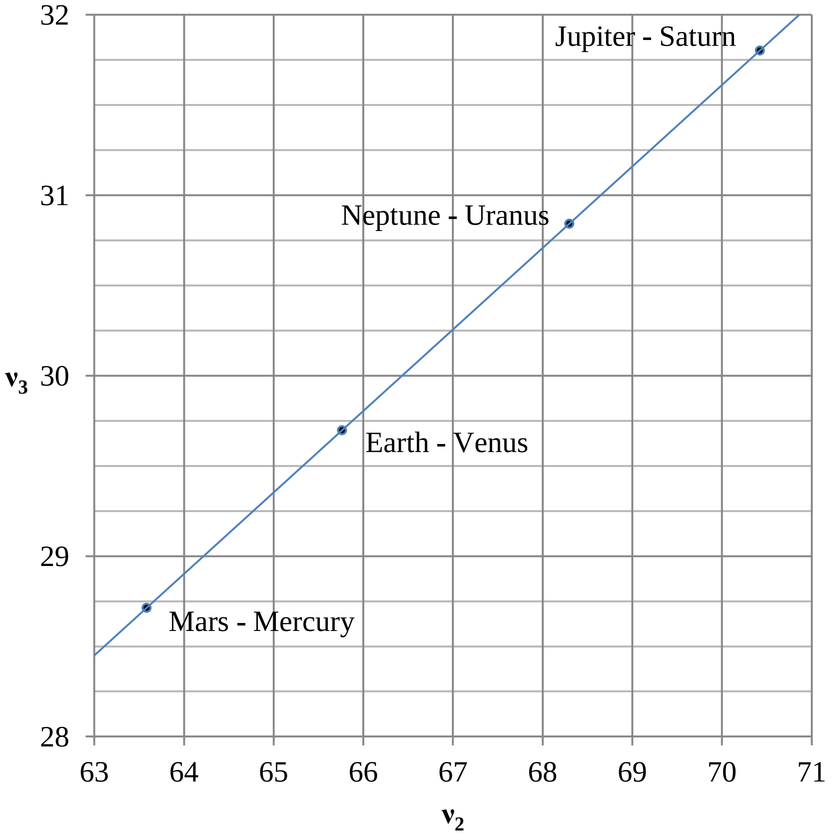


Figure 8: The planets as four pairs of twins in symmetrical arrangement about Level 67 in Sequence 2, on the trans-Planckian levels of Sequences 2 and 3. Each pair is represented by the length scale corresponding to the geometric mean of the two planetary masses.

The planetary arrangement of Figure 8 is centred on the level scale that corresponds to the four-dimensional mass scale $(1/\pi)^{10}m_{Sun} \approx (2/\pi)^{25}m_{Sun}$, as shown in Figure 9. The quantity $(2/\pi)^{25}$ is an important factor in the Planck Model, relating, together with the fine structure constant, many of the scales of particle physics [5]. Of interest to us here is the relationship $m_{u-d}c^2 \approx (2/\pi)^{25}\upsilon$, where m_{u-d} is the geometric mean of the up and down quark masses and υ is the Higgs field vacuum expectation value (246 GeV). Higgs field coupling constants are, in general, incorporated into Sequence 2 of the Planck Model [8]. The relationship between the mass of the Sun and those of its planets is analogous to that between the Higgs field VEV and the masses of the up and down quarks.

The planetary arrangements of Figures 8 and 9 suggest that the eight planets of the Solar System do, as conjectured, comprise four pairs of twins. Three of the pairs (Earth – Venus, Jupiter – Saturn and

Neptune – Uranus) consist of planets with adjacent orbits. The Mars – Mercury pairing seems to have been broken spatially although the mass relationship remains.

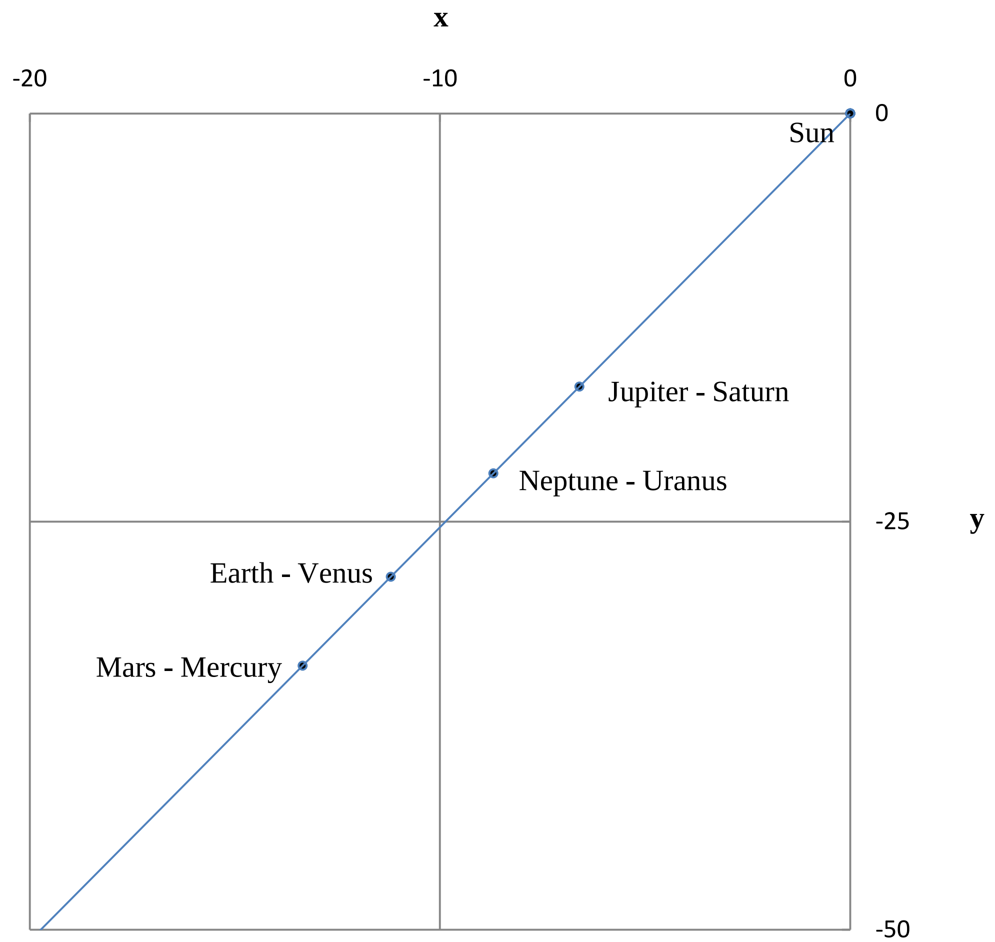
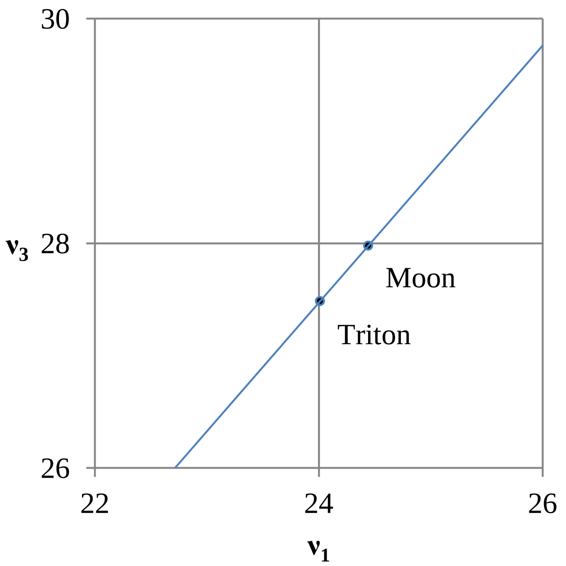


Figure 9: The planets as four pairs of twins in symmetrical arrangement about (x, y) = (-10, -25): each point (x, y) on the blue line refers to a (four-dimensional) mass scale $\pi^x M_{Star} = \left(\frac{\pi}{2}\right)^y M_{Star}$. Each pair of twins is represented by the mass scale corresponding to the geometric mean of the two planetary masses.

Like the planets, the moons of the solar system occupy trans-Planckian levels and sublevels. Three planets possess either a solitary moon (Earth's Moon) or one that is highly pre-eminent in mass (Saturn's Titan and Neptune's Triton). The Moon and Triton both occupy principal trans-Planckian levels, while Titan occupies a half-level, as shown in Figure 10. Six planets have at least one moon; the most massive moon in orbit around each of the planets occupies either a trans-Planckian level or prominent sublevel, as shown in Figure 11. The major moons around each planet occupy trans-

Planckian sublevels, as shown in Figure 12 (Jupiter), Figure 13 (Saturn), Figure 14 (Uranus) and Figure 15 (Mars). Neptune has only one major satellite.



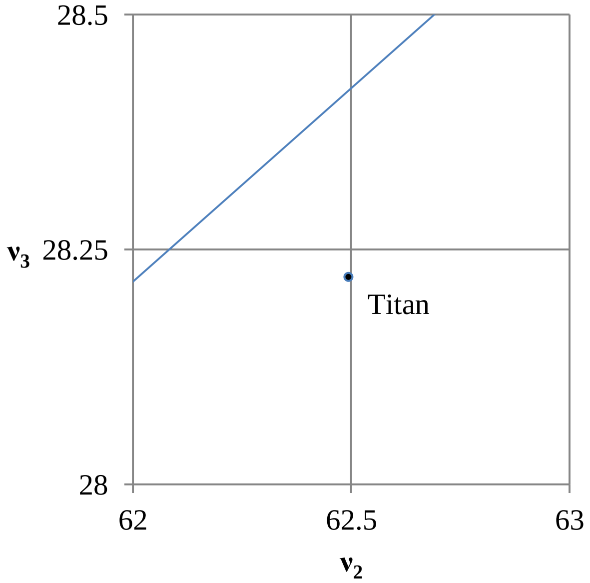


Figure 10: The Moon (the solitary satellite of the earth), Titan and Triton (the pre-eminent satellites in orbit around Saturn and Neptune, respectively), on the trans-Planckian levels and sublevels of Sequences 1, 2 and 3.

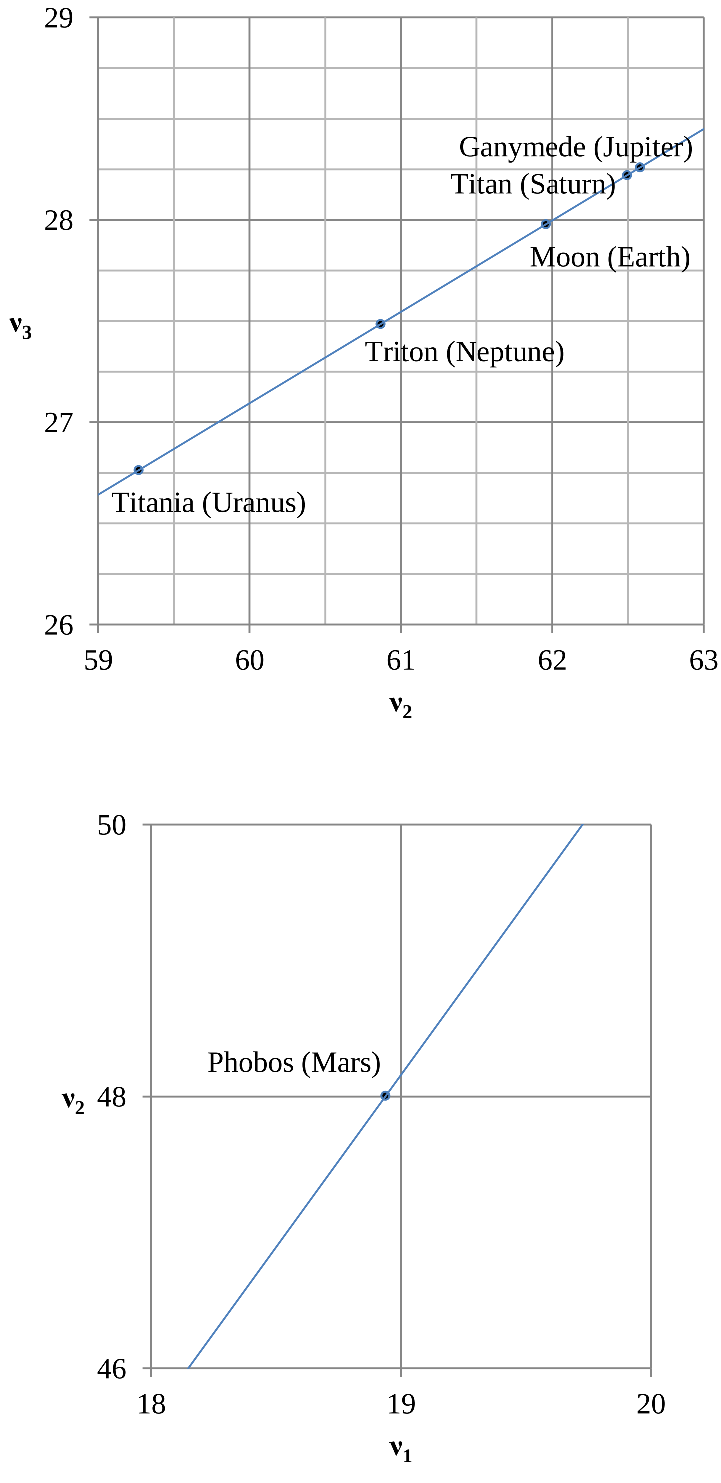


Figure 11: The most massive moon orbiting each planet that has satellites; shown on the trans-Planckian levels and sublevels of Sequences 1, 2 and 3.

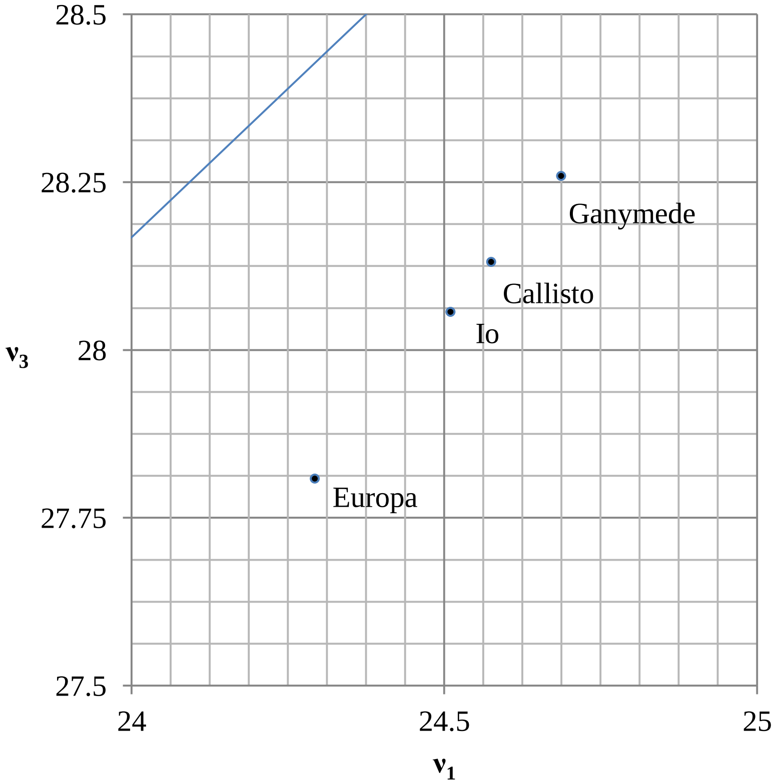


Figure 12: The Galilean Moons of Jupiter on the trans-Planckian levels and sublevels of Sequences 1 and 3.

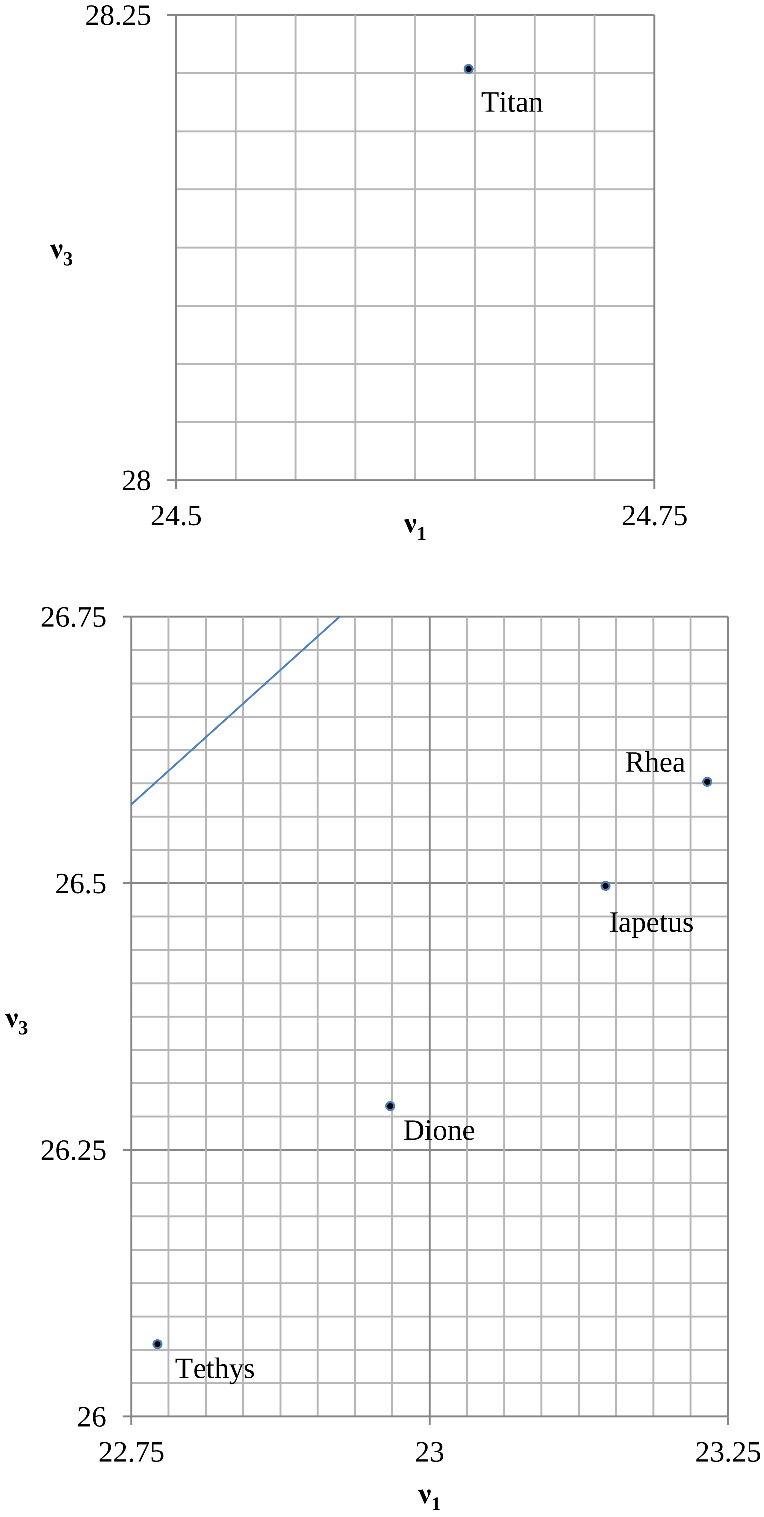


Figure 13: The five most massive moons of Saturn on the trans-Planckian levels and sublevels of Sequences 1 and 3.

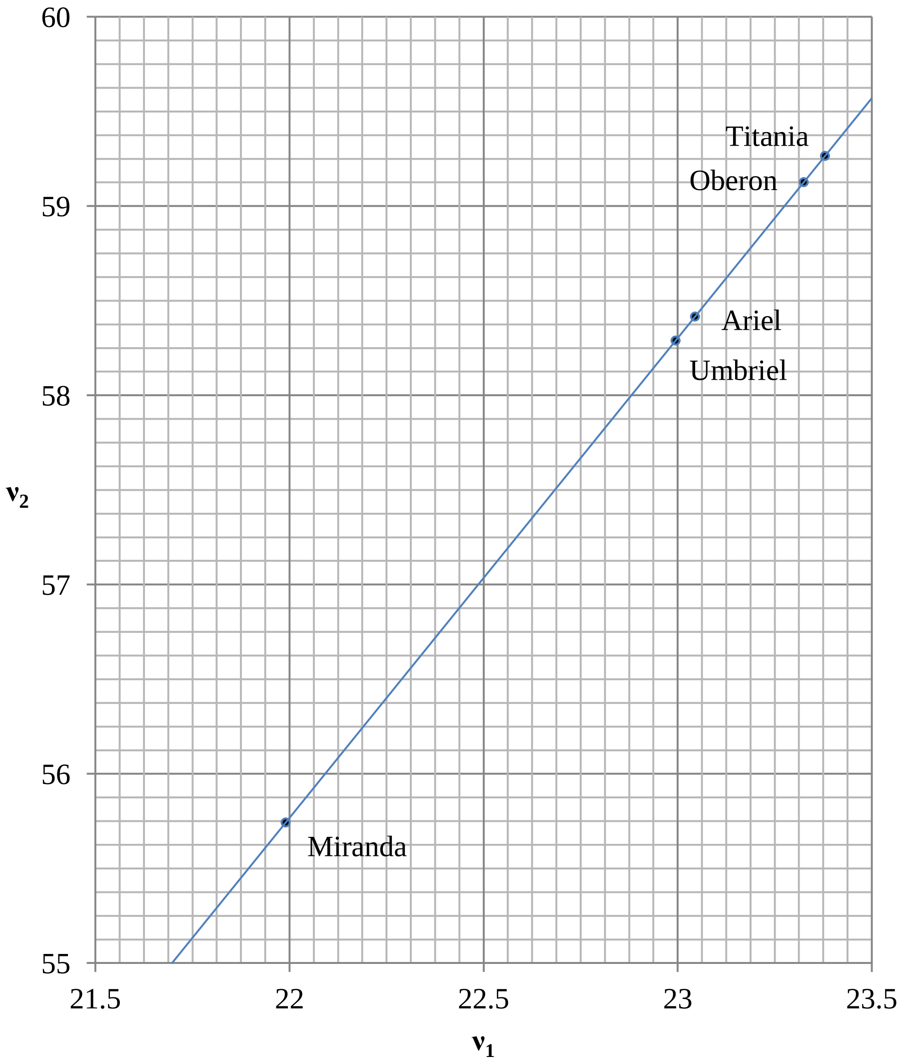


Figure 14: The five most massive moons of Uranus on the trans-Planckian levels and sublevels of Sequences 1 and 2.

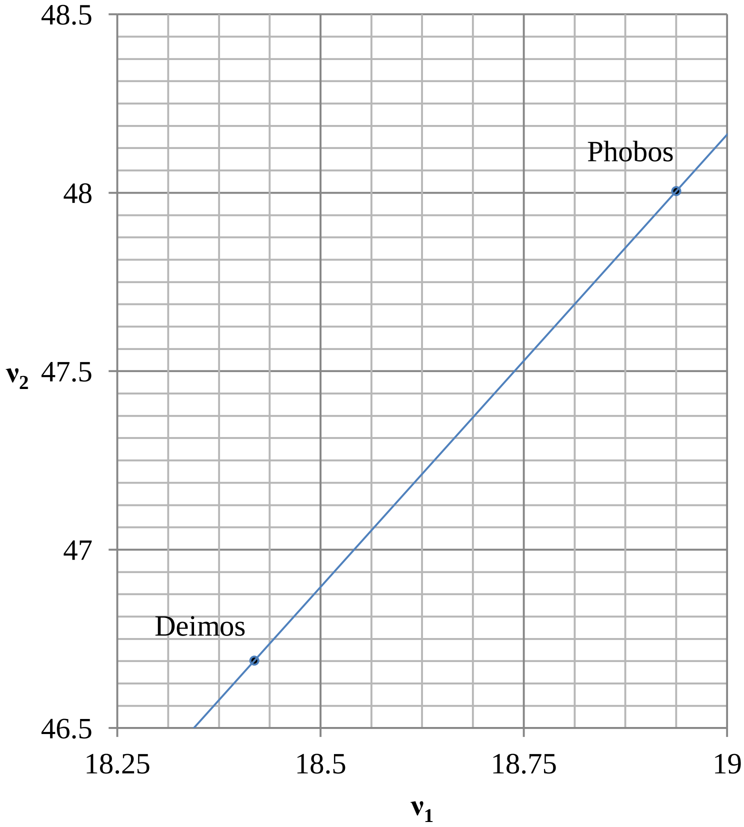


Figure 15: The Martian moons on the trans-Planckian levels and sublevels of Sequences 1 and 2.

4 Exoplanets

Since the planets of the Solar System have been found to occupy trans-Planckian levels in symmetrical arrangement a study has been made of exoplanetary systems, looking for similar behaviour. The closest planetary system to ours, that of Alpha Centauri B, which possesses a single planet, was investigated, as were all systems of three or more confirmed planets within 25 light years of Earth, as shown in Table 1. Also included is the 'controversial' planetary system of tau Ceti. Data have been taken from the Open Exoplanet Catalogue [9, 10].

Star (mass in m_{Sun})	Exoplanets (mass in $m_{Jupiter}$)
Alpha Centauri B (0.934)	b (0.0036)
tau Ceti (0.783)	b (0.0063), c (0.0098), d (0.0113), e (0.0135), f (0.0208)
Gliese 876 (0.370)	b (2.67), c (0.843), d (0.022), e (0.054)
Gliese 581 (0.310)	b (0.0497), c (0.0173), e (0.0061)

Table 1: The planetary systems investigated

Alpha Centauri B b is approximately of Earth's mass so, not surpisingly, it lies on the trans-Planckian level-coincidence (26, 66) in Sequences 1 and 2, as shown in Figure 16. Relative to its star, Alpha Centauri B b is of mass $(1/\mathrm{e})^{12.5} m_{ACB}$, as shown in Figure 17.

The five-planet system of tau Ceti is arranged symmetrically about Level 67 in Sequence 2 (Figure 18), as are the planets of the Solar System (Figure 8). Relative to their star, the planets are symmetrically arranged about the mass scale $(1/\pi)^{10} m_{\tau C} \approx (2/\pi)^{25} m_{\tau C}$ (Figure 19), i.e. similarly, although more tightly distributed, to the planets of the Solar System (Figure 9).

The four-planet system of Gliese 876 is arranged symmetrically about (27.5, 31.5) in Sequences 1 and 3, as shown in Figure 20. Relative to their star, the planets are symmetrically arranged about the mass scale $(1/\mathrm{e})^{7.5} m_{G876}$, as shown in Figure 21.

The three planets of Gliese 581 occupy the trans-Planckian levels and sublevels of Sequences 2 and 3, as shown in Figure 22. Relative to their star, the planets are symmetrically arranged about the mass scale $(1/\mathrm{e})^{10} m_{G581}$, as shown in Figure 23.

The (geometric) mean mass of the planets in each planetary system considered in this paper is shown in comparison with the mass of the system's star in Figure 24. The mass values lie on the sublevels of two sequences, of common ratio $(1/e)^{10}$ and $(2/\pi)^{25}$, that descend from the mass scale of the corresponding star. We see that planetary systems are related in mass to their star by way of a gravitational coupling constant incorporated within the trans-Planckian scheme. We have already observed that Higgs field coupling constants are incorporated within the cis-Planckian scheme [8]: subatomic particles lie on the sublevels of a sequence of common ratio $(2/\pi)^5$ that descends from the Higgs field vacuum expectation value.

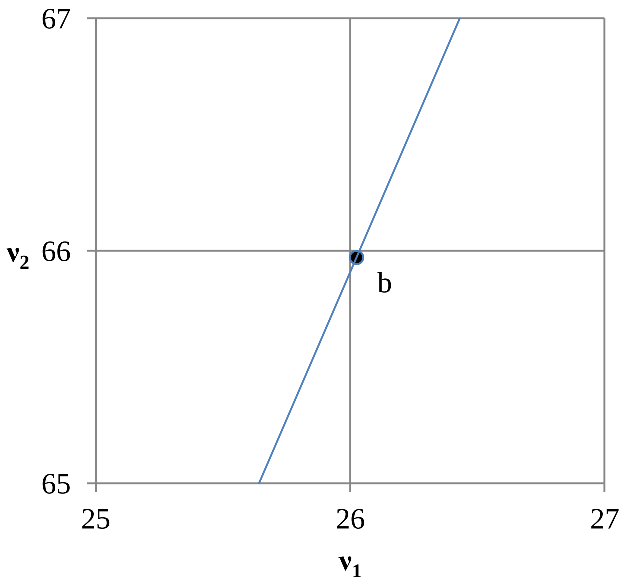


Figure 16: The exoplanet (b) orbiting Alpha Centauri B, shown on the trans-Planckian levels and sublevels of Sequences 1 and 2.

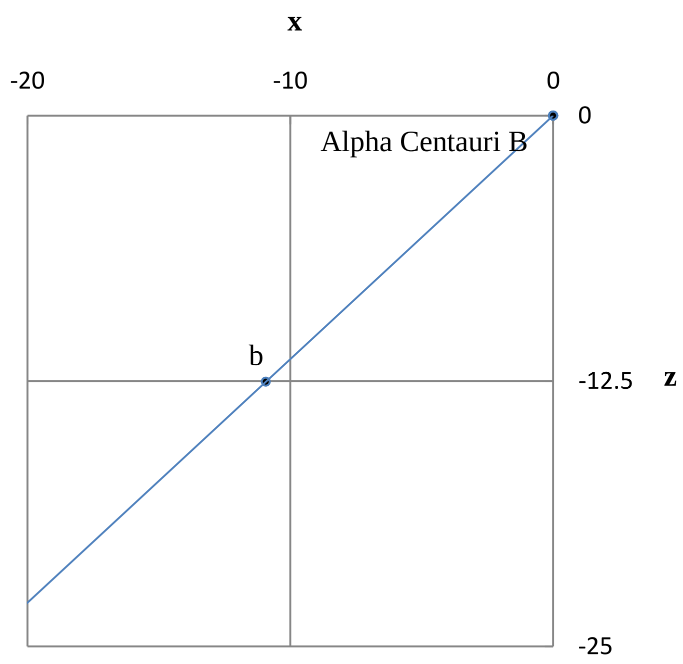


Figure 17: The exoplanet (b) orbiting Alpha Centauri B, compared in mass with its star: each point (x, z) on the blue line refers to a planetary mass scale $\pi^x M_{Star} = e^z M_{Star}$.

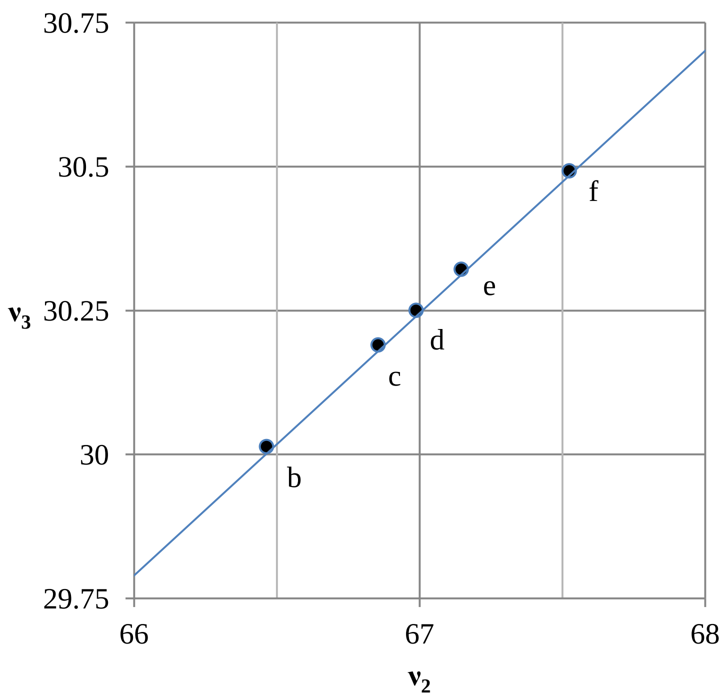


Figure 18: The nearby planetary system of tau Ceti on the trans-Planckian levels and sublevels of Sequences 2 and 3.

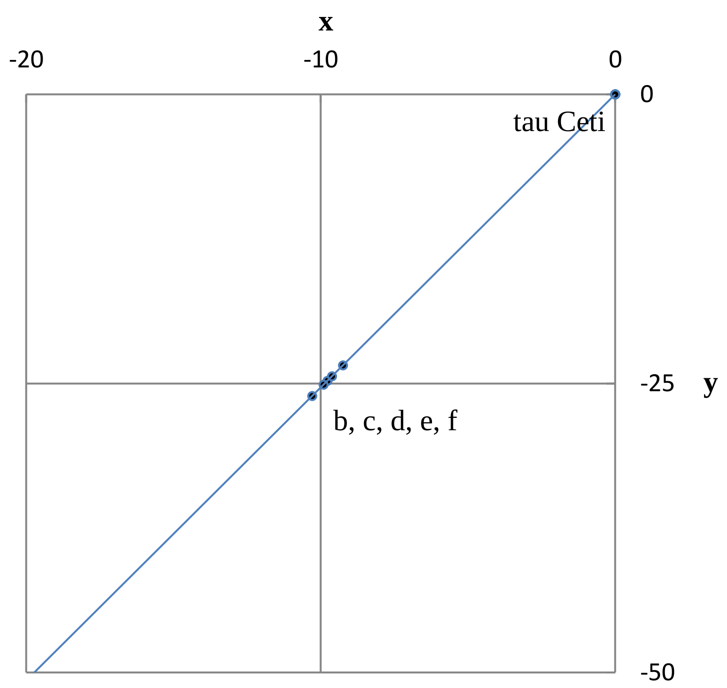


Figure 19: The exoplanets orbiting tau Ceti, compared in mass with their star: each point (x, y) on the blue line refers to a planetary mass scale $\pi^x M_{Star} = \left(\frac{\pi}{2}\right)^y M_{Star}$.

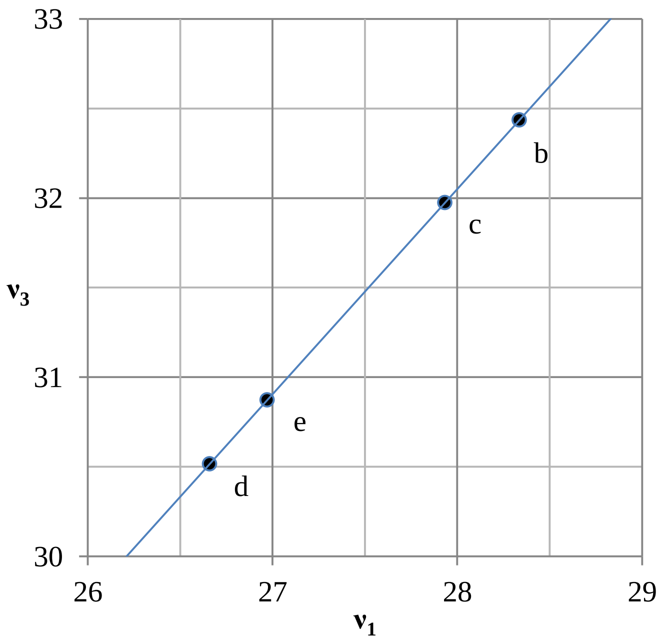


Figure 20: The nearby planetary system of Gliese 876 on the trans-Planckian levels and sublevels of Sequences 1 and 3.

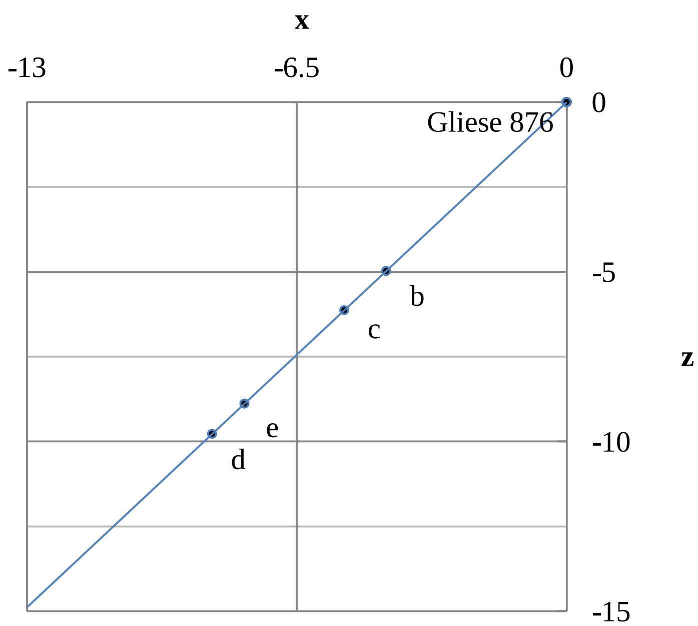


Figure 21: The exoplanets orbiting Gliese 876, compared in mass with their star: each point (x, z) on the blue line refers to a planetary mass scale $\pi^x M_{Star} = e^z M_{Star}$.

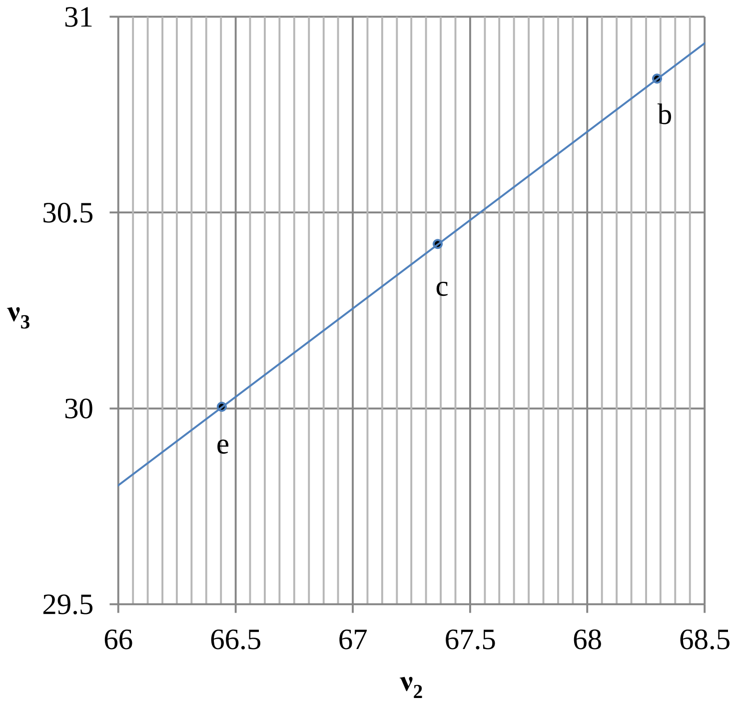


Figure 22: The nearby planetary system of Gliese 581 on the trans-Planckian levels and sublevels of Sequences 1 and 3.

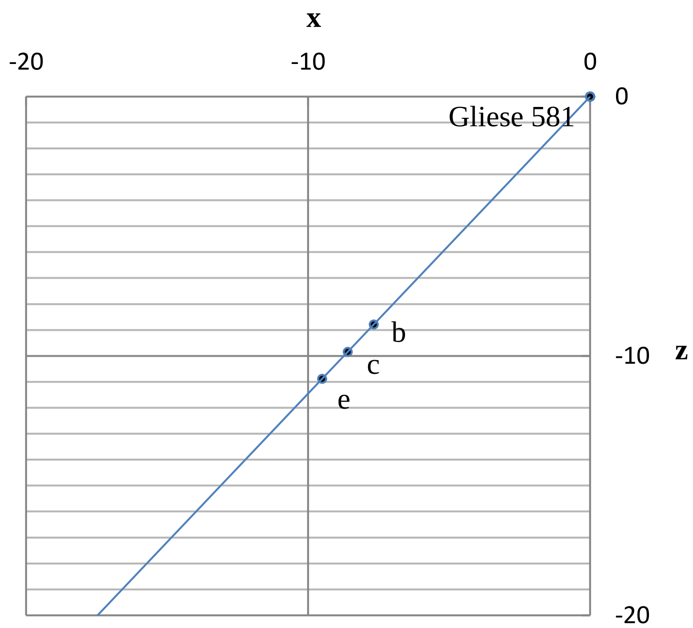


Figure 23: The exoplanets orbiting Gliese 581, compared in mass with their star: each point (x, z) on the blue line refers to a planetary mass scale $\pi^x M_{Star} = e^z M_{Star}$.

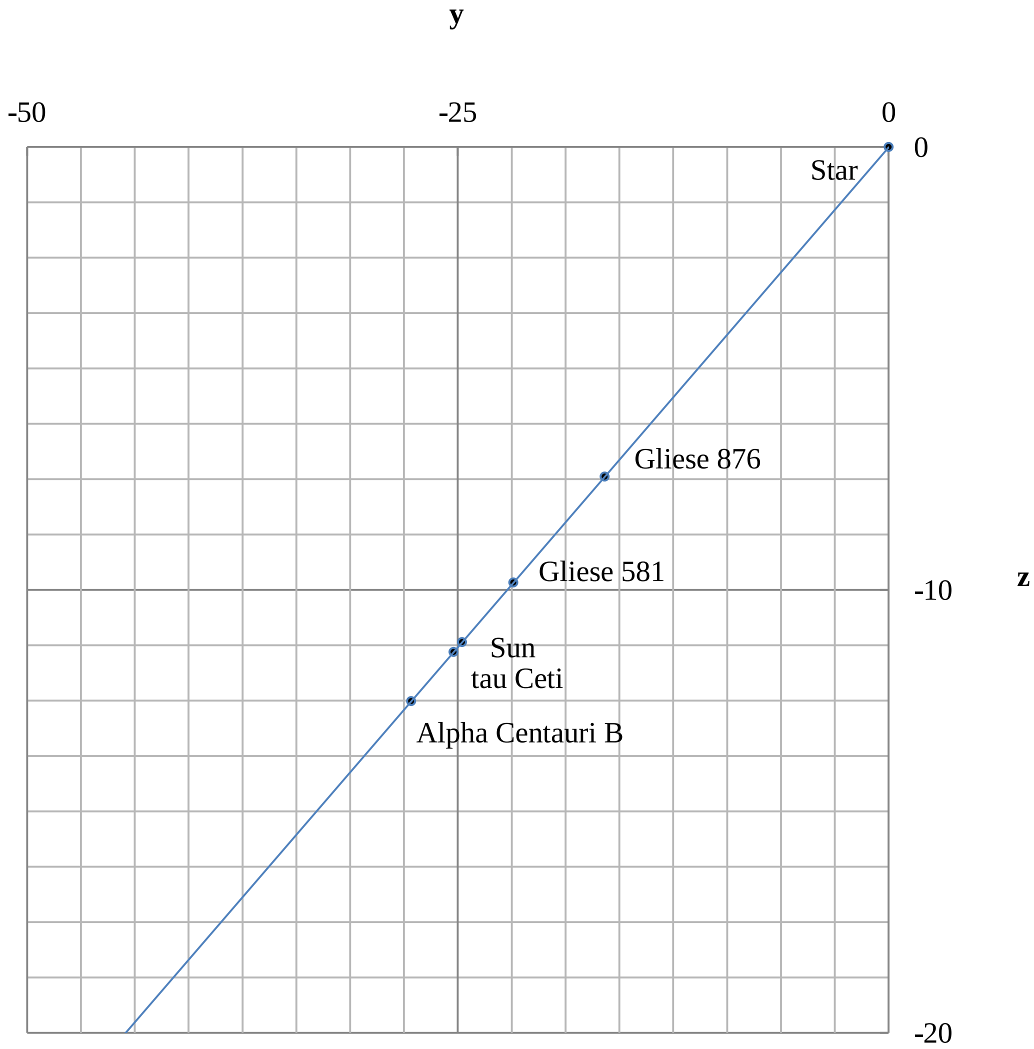


Figure 24: The (geometric) mean mass of the planets in a planetary system, compared with the mass of the system's star: each point (y, z) on the blue line refers to a planetary mass scale $\left(\frac{\pi}{2}\right)^y M_{Star} = e^z M_{Star}$.

5 The Planck Model

As currently perceived:

Particle mass scales are derived from a ten-dimensional geometry and correspond to four-dimensional cosmological length scales. On trans-Planckian scales, ten-dimensional length scales correspond to the four-dimensional mass scales of gravitationally bound celestial objects.

Higgs field coupling constants derive from the ten-dimensional geometry [8].

If the mass of a gravitationally bound celestial object corresponds to a specific ten-dimensional length scale l_o then a subatomic particle of mass $m_p = l_o$ is the analogue of that object [1].

Black holes are analogous to subatomic particles [1]. The supermassive black hole is the analogue of the atomic nucleus.

Planetary systems are symmetrically arranged within the ten-dimensional geometry. The planets of the Solar System comprise four pairs of twins in symmetric arrangement.

A planetary system is related in mass to its star through a gravitational coupling constant that derives from the ten-dimensional geometry.

6 References

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