Our Observations Create Our Reality

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When observed, macroscopic lengths and distances, and elapsed times, adopt values that in Planck units are equal to integer, half-integer, quarter-integer, eighth-integer, etc powers of π or e. The values of the parameters then lie on the levels and sub-levels of two geometric sequences that ascend from Planck scale with common ratio π and e, respectively. Closely coincident levels and sub-levels in the two sequences are the most probable locations for the parameters of conspicuous objects. Many parameters are considered: earthly, astronomical and of the universe.

Introduction

When observed, macroscopic parameters adopt discrete values [1, 2], which in natural units are equal to integer, half-integer, quarter-integer, eighth-integer, etc powers of π or e. Measurements of length and distance then lie on principal levels of integer level-number and sub-levels of half-integer, quarter-integer, eighth-integer, etc level-number in one of two geometric sequences of length-scale that ascend from the Planck length: Length Sequence 1 of common ratio π and Length Sequence 3 of common ratio e. Levels in Length Sequences 1 and 3 are numbered n_1 and n_3, respectively. Length Sequence 2, of common ratio π/2, is reserved for atomic and sub-atomic scales. The three sequences may derive from the geometry of spacetime [3]. *Despite the inconstancy of interstellar distances* the distances measured between Earth and the stars and other celestial bodies and objects lie on principal levels or sub-levels in Length Sequences 1 and 3. The distances from Earth of the most conspicuous bodies and objects, such as the brightest or most luminous bodies and objects, are the most likely to lie on principal levels and sub-levels of low order[1].

In this paper, many parameters will be shown to lie on principal levels and sub-levels in the length sequences or in the parallel time sequences that ascend from the Planck time. Prominent parameters will be shown to lie on 'intersecting' (closely coincident) principal levels, low-order sub-levels and, especially, super-levels[2] in Sequences 1 and 3. 'Notable' intersections are defined as those for which n_3 is a multiple of 20, e.g. (70, 80) and (87.5, 100), and will be shown to frame a hierarchy of scales.

CODATA 2018 values of the Planck units (length and time) have been used for the calculation of level-numbers. The level-numbers are plotted one against the other, the markers lying on a straight line (shown in blue) since the level-numbers in the two sequences are in constant ratio.

The results are discussed.

The Metre

The metre, the SI base unit of length, and of human scale, lies close to Level 70 in Length Sequence 1 at the notable intersection (70, 80), as shown in Figure 1. The yard (0.9144 m) lies close to Level 80 in Length Sequence 3.

[1] Low-order sub-levels are of half-integer and quarter-integer level-number.
[2] Super-levels are principal levels whose level-numbers are multiples of 5.

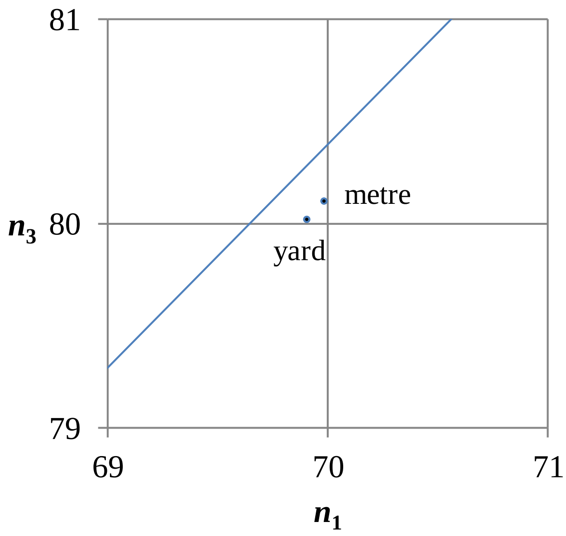

Figure 1: The metre and the yard at the notable intersection (70, 80) in Length Sequences 1 and 3

The Centimetre

The centimetre, the CGS base unit of length, lies on Level 75.5 in Sequence 3 at the intersection (66, 75.5), as shown in Figure 2. The inch (2.54 cm) is shown on a sub-level in Sequence 3.

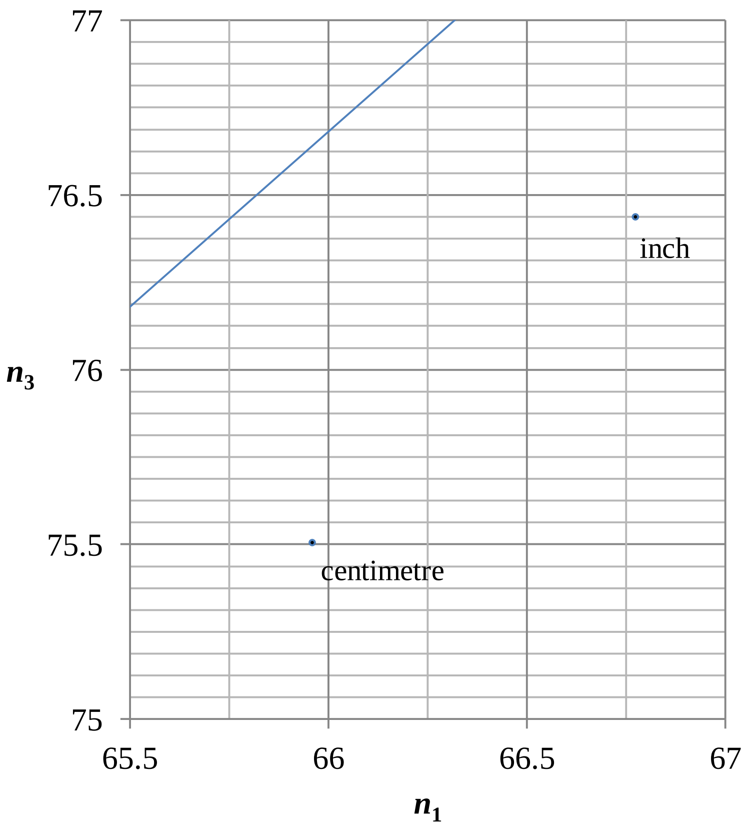

Figure 2: The centimetre and the inch in Length Sequences 1 and 3

The Kilometre

The kilometre lies close to the intersection (76, 87), as shown in Figure 3. The mile (1.6093 km) lies close to Level 87.5 in Sequence 3.

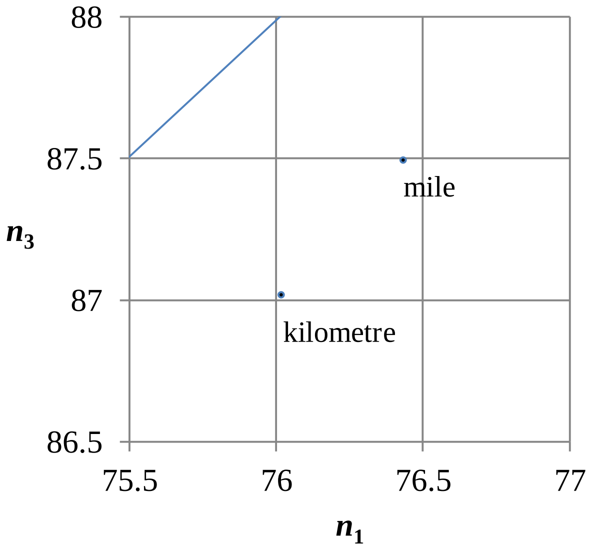

Figure 3: The kilometre and the mile in Length Sequences 1 and 3

The Day and the Month

The solar day (24 hours) lies on Level 111 in Time Sequence 3 at the intersection (97, 111), as shown in Figure 4. The month (30.44 days) lies close to Level 100 in Sequence 1 at the super-level intersection (100, 115), as shown in Figure 5.

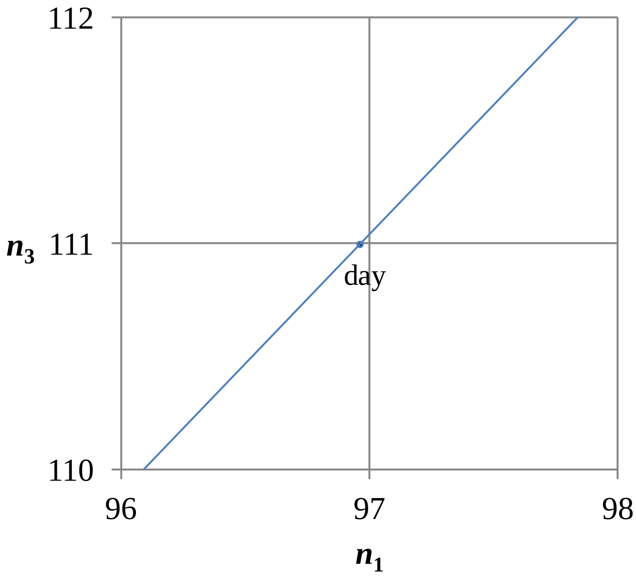

Figure 4: The solar day (24 hours) in Time Sequences 1 and 3

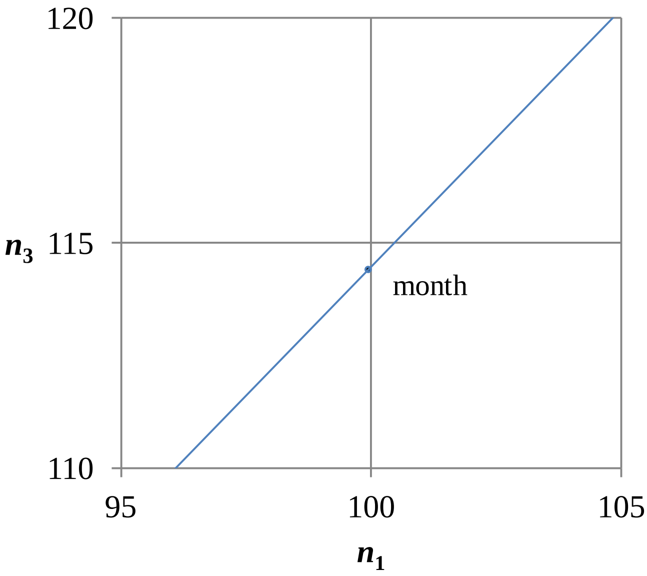

Figure 5: The month (30.44 days) at the super-level intersection (100, 115) in Time Sequences 1 and 3

The **Earth, Sun and Moon**

The mean distances from Earth of the Sun and the Moon, together with the radii of the two celestial bodies, lie in symmetrical arrangement about the notable intersection (87.5, 100), as shown in Figure 6. As a result of this arrangement the Sun and Moon appear the same size in our skies. The symmetry about Level 87.5 in Sequence 1 is quite precise. The geometric mean value of the semi-major axis of Earth's orbit and the radius of the Moon is of level-number 87.50 in Length Sequence 1. The close symmetrical arrangement of the radius of the Sun and the semi-major axis of the Moon's orbit (equal to the mean distance from Earth of the Moon) is shown in Figure 7. Also shown in Figure 7, on sub-levels, are the diameter of the Sun and the distance light travels in one second, the light-second. While it is the radii of the Sun and the Moon that are included in the symmetrical arrangement of Figure 6 it is the diameters of the bodies that lie on sub-levels. We have shown that the radii of celestial bodies map by way of the Quantum/Classical connection onto the principal levels and sub-levels of the sub-Planckian mass sequences [4]. In this paper we show that it is the diameter of a celestial body, which is actually measured in the first place, that lies on a principal level or sub-level of the length sequences.

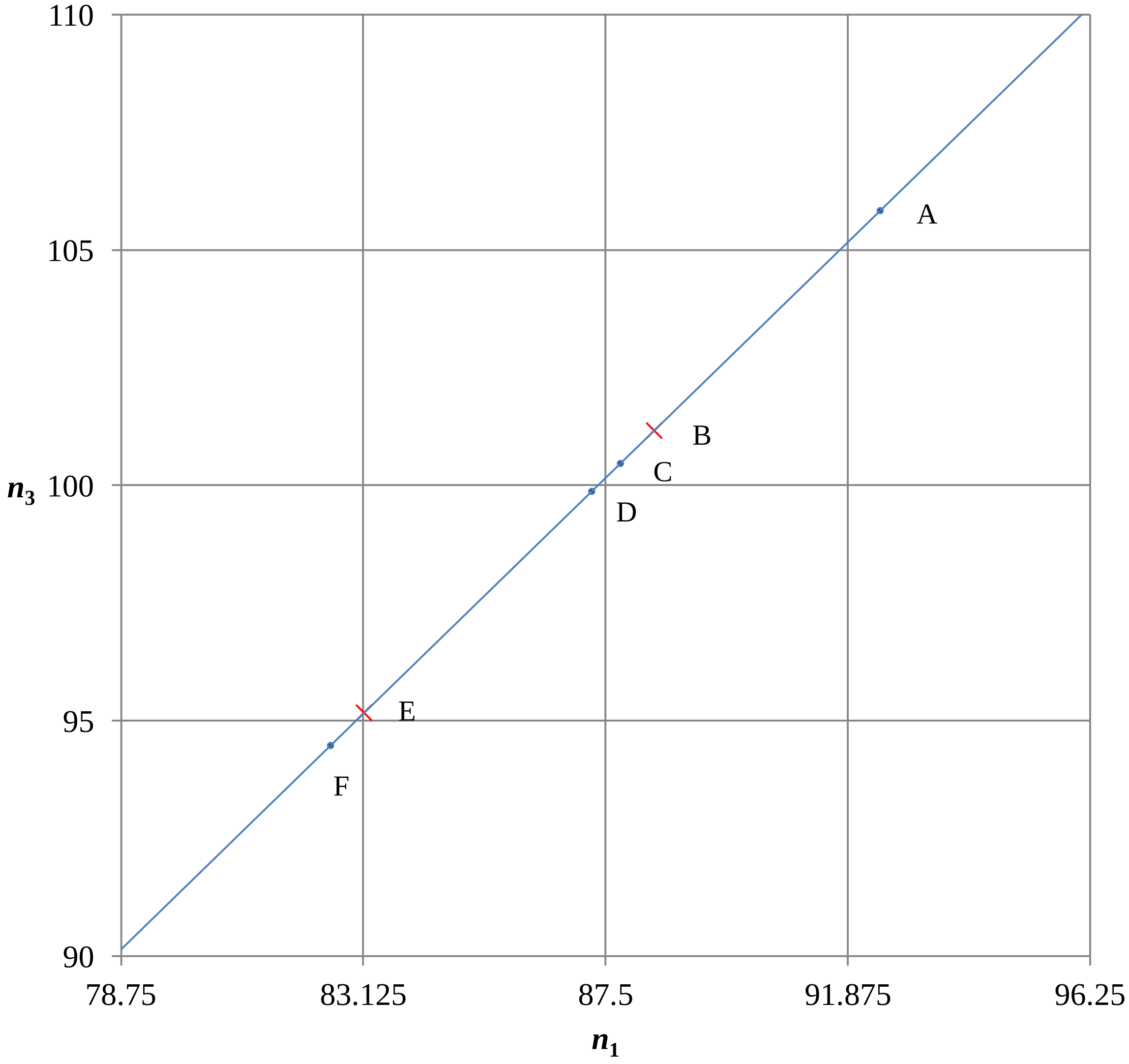

Figure 6: The distances from Earth of the Sun and the Moon, and the diameters and radii of the two celestial bodies, arranged about the notable intersection (87.5, 100) in Length Sequences 1 and 3. The data are from [5].

A The semi-major axis of Earth's orbit (1.496×10^8 km)
B The diameter of the Sun
C The volumetric mean radius of the Sun (6.957×10^5 km)
D The semi-major axis of the Moon's orbit (3.844×10^5 km)
E The diameter of the Moon
F The volumetric mean radius of the Moon (1.737×10^3 km)

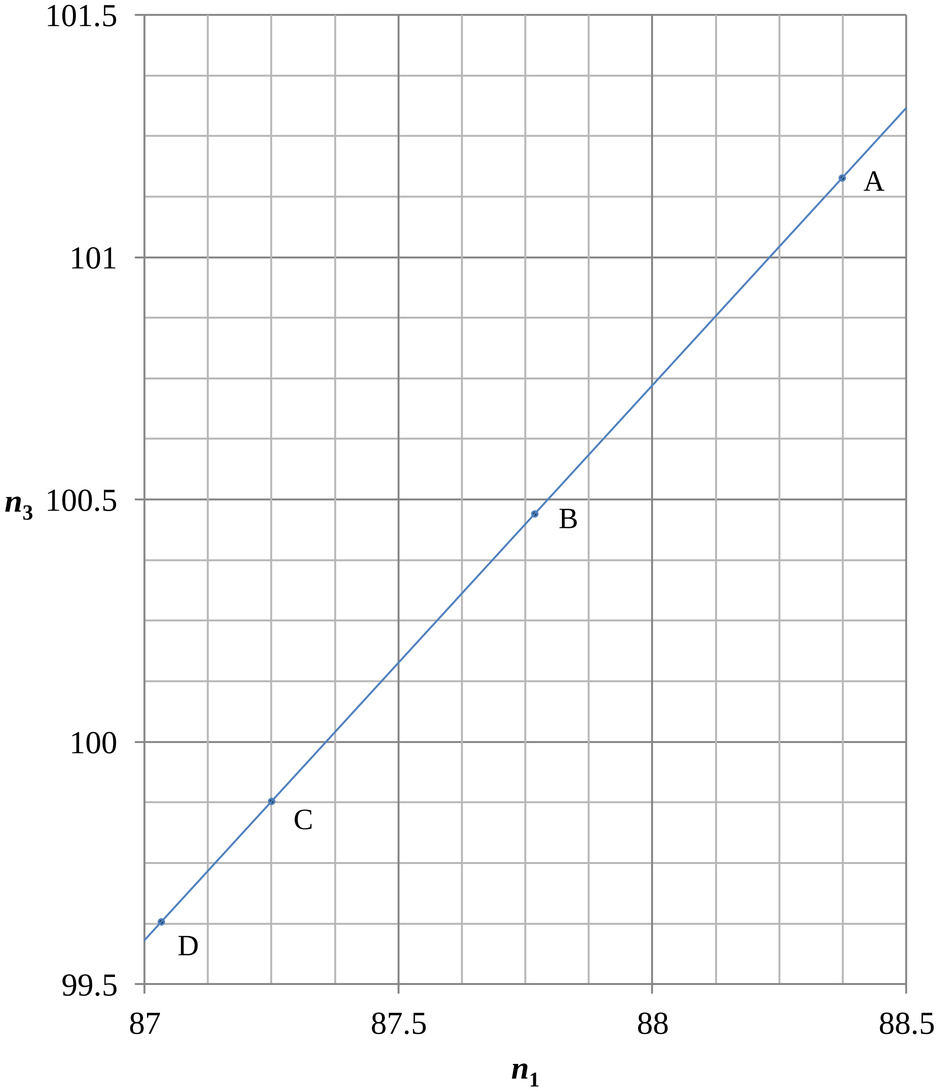

Figure 7: Detail of Figure 6
A The diameter of the Sun
B The radius of the Sun
C The mean distance from Earth of the Moon
D The light-second

The Geostationary Satellite

A geostationary satellite orbits at a height above Earth's surface of 35,786 km. This distance occupies Level 97.5 in Length Sequence 3 at the intersection (85, 97.5), as shown in Figure 8.

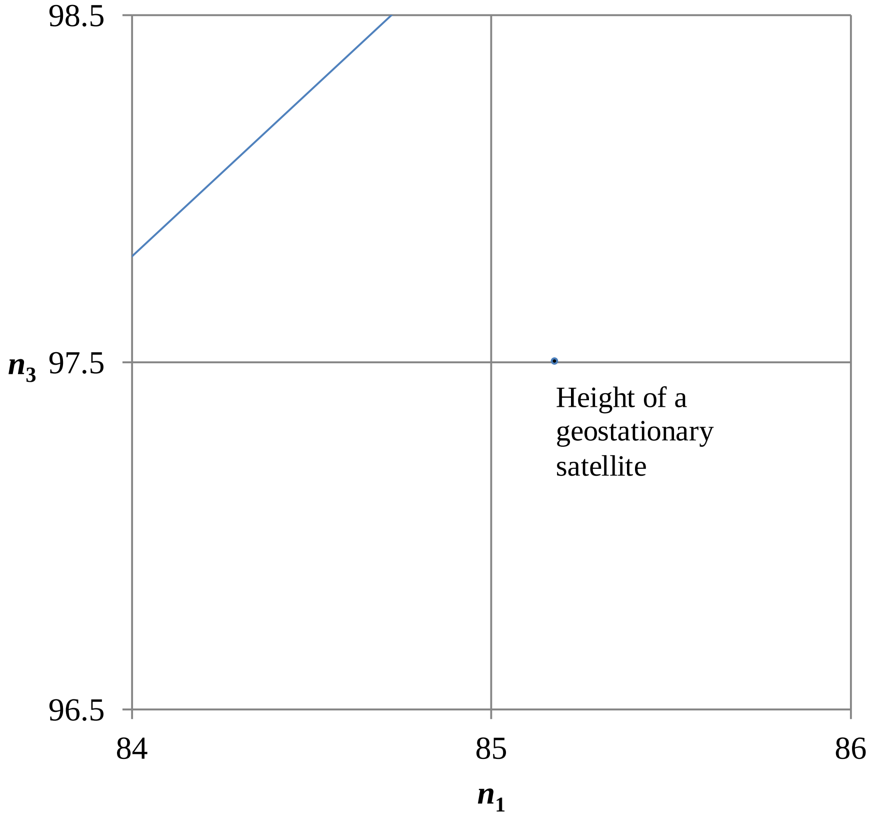

Figure 8: The distance above Earth's surface (35,786 km) of a geostationary satellite in Length Sequences 1 and 3.

The Galilean Satellites of Jupiter

The diameters of Jupiter's four largest moons [5] are shown on the sub-levels of Length Sequences 1 and 3 in Figure 9. The diameters of both Ganymede (5262 km) and Callisto (4821 km), the two largest moons, are shown on half-levels at the same intersection, (83.5, 95.5). Io (3643 km) and Europa (3121.6 km) are shown on higher order sub-levels.

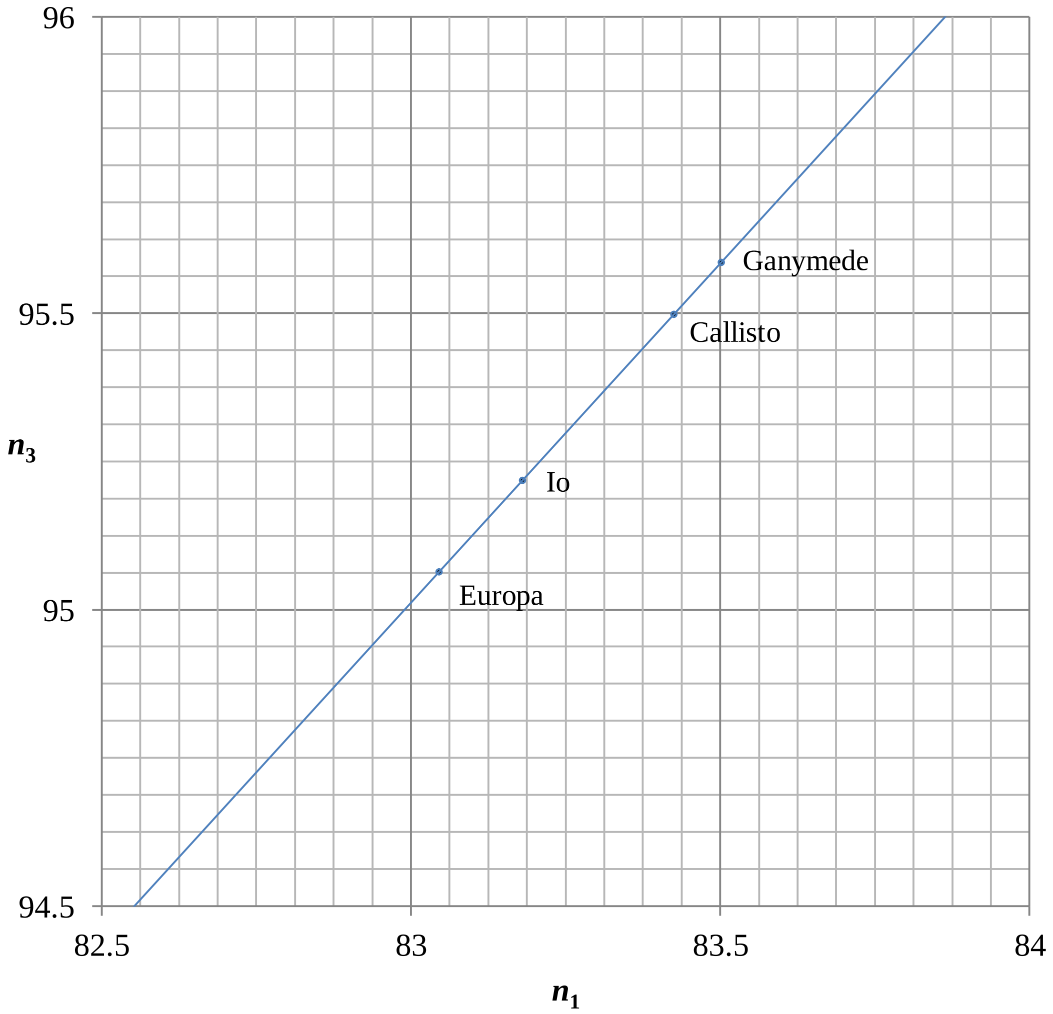

Figure 9: The diameters of the Galilean satellites of Jupiter on the sub-levels of Length Sequences 1 and 3

Asteroids

The geometric mean diameters of the three largest asteroids: Ceres (939.4 ± 0.2 km [6]); Vesta (525.4 ± 0.2 km [6]); and Pallas (512 ± 6 km [7]) are shown on the principal levels and low-order sub-levels of Length Sequences 1 and 3 in Figure 10. The diameter of Ceres, the largest asteroid, lies on a principal level (Level 82 in Length Sequence 1). The diameter of Hygiea (434 ± 14 km [8]), the fourth largest asteroid, is more uncertain than the diameters of the larger three asteroids but it probably does not lie on a low-order sub-level.

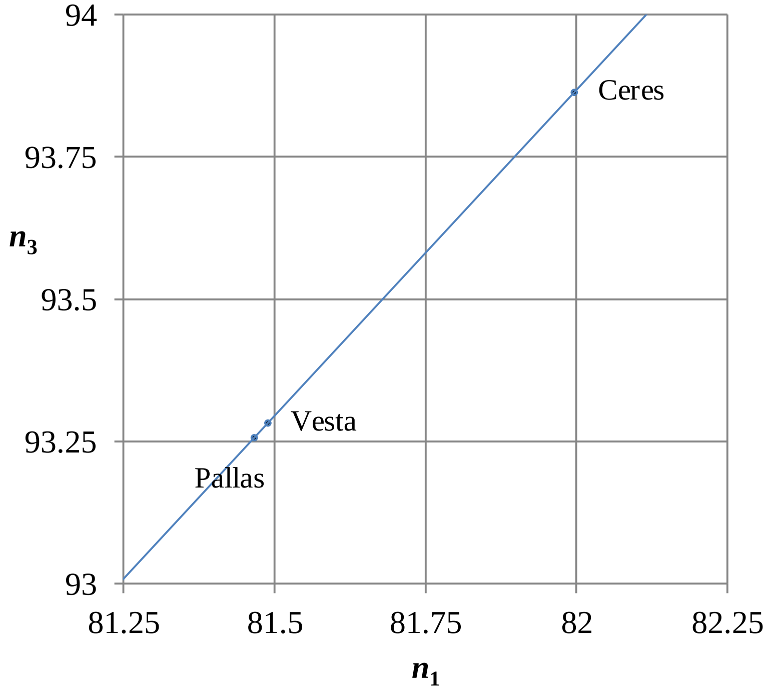

Figure 10: The geometric mean diameters of the three largest asteroids, Ceres, Vesta and Pallas on the principal levels and low-order sub-levels of Length Sequences 1 and 3.

The rotation periods of the four largest asteroids: Ceres (9.074 h [6]); Vesta (5.342 h [6]); Pallas (7.813 h [6]); and Hygiea (13.826 h [8]) lie on principal levels and half-levels in the time sequences, as shown in Figure 11.

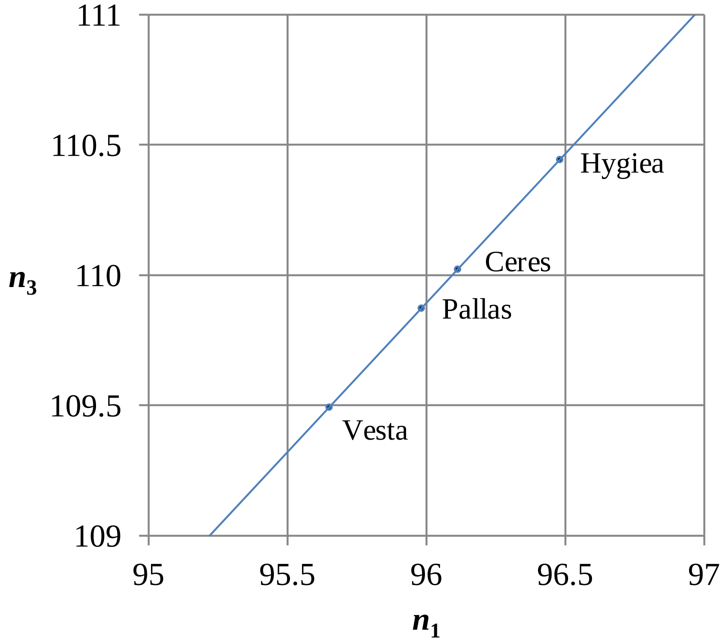

Figure 11: The rotation periods of the asteroids Ceres, Vesta, Pallas and Hygiea on the principal levels and half-levels of Time Sequences 1 and 3.

The shortest distances above Earth's surface of the three closest known non-impacting asteroids to pass by Earth are shown in Table 1.

Asteroid	**Closest distance above Earth's surface (km)**
2020 QG	2946 ± 20
2011 CQ_1	5481 ± 5
2019 UN_{13}	6242 ± 200

Table 1: The shortest distances above Earth's surface of the three closest known non-impacting asteroids to pass by Earth. The values have been calculated from the close approach data in [6].

The three distances are shown on the principal levels and sub-levels of Sequences 1 and 3 in Figure 12. The asteroid to have most closely passed Earth, 2020 QG, lies on the very close principal level intersection (83, 95).

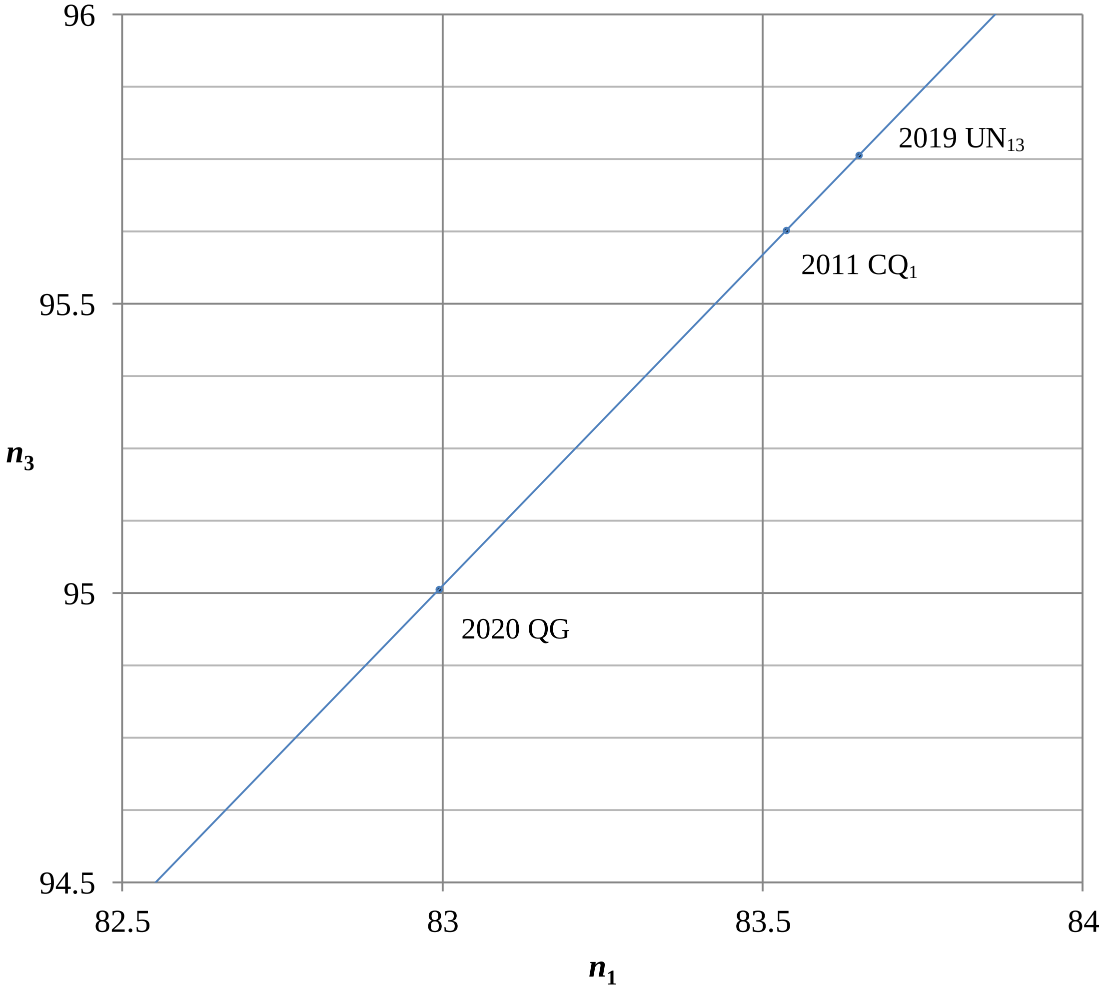

Figure 12: The closest distances from Earth's surface of the non-impacting asteroids 2020 QG, 2011 CQ_1 and 2019 UN_{13} on the principal levels and sub-levels of Length Sequences 1 and 3.

Before interacting with Earth, the semi-major axis (mean distance from the Sun) of asteroid 2020 QG was 1.9448 ± 0.0006 AU, or 2.909×10^8 km [6]. This distance lies on Level 106.5 in Length Sequence 3 at (93, 106.5), as shown in Figure 13.

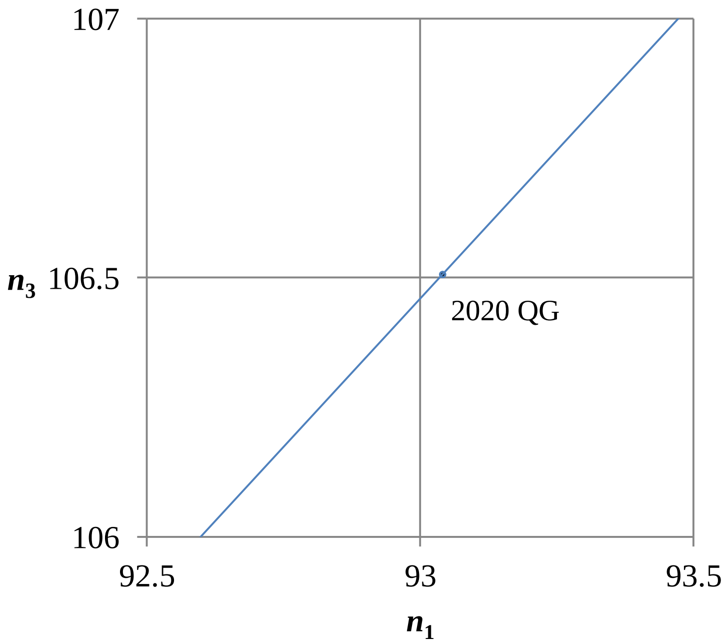

Figure 13: The semi-major axis of asteroid 2020 QG before it passed by Earth in 2020; shown in Length Sequences 1 and 3

The Distances of the Brightest Stars

The distance from Earth of the bright Vega was measured before the distance of any other star in the night skies. The distance of Vega (25.0 light-years) lies on a sub-level in Length Sequence 3, immediately adjacent to the notable intersection (105, 120), as shown in Figure 14 together with the distances of Alpha Centauri (4.37 light-years), Sirius (8.60 light-years), Procyon (11.5 light-years) and Arcturus (36.7 light-years). These five stars are the closest to Earth of the eight brightest stars in the night skies. The distance of Sirius, the star with the greatest apparent brightness, lies on a principal level (Level 104 in Sequence 1) at the intersection, (104, 119), of two principal levels.

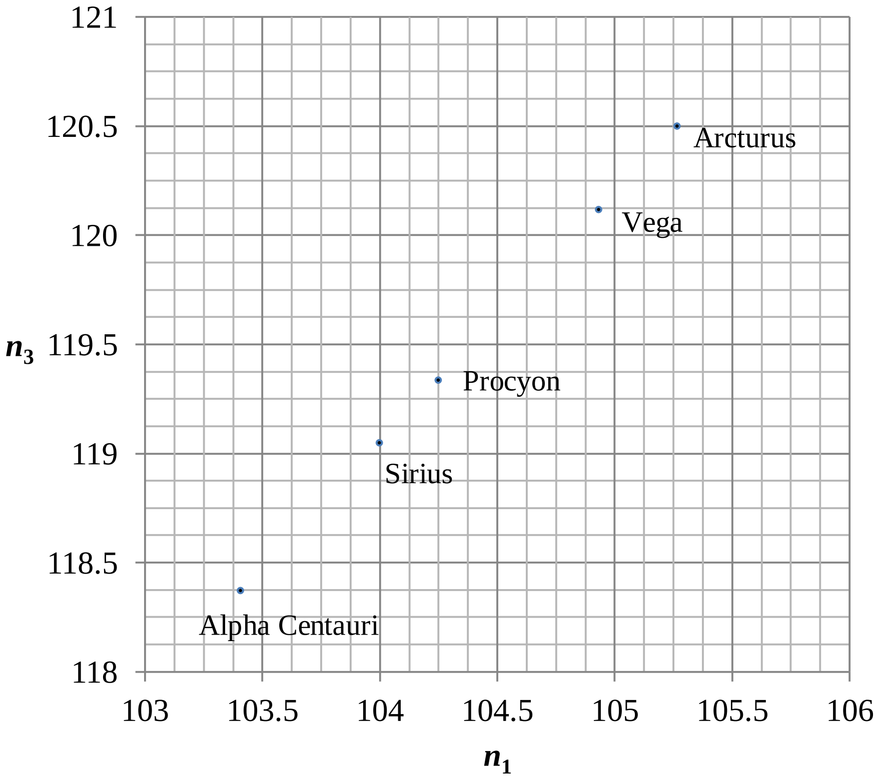

Figure 14: The distances from Earth of the bright stars Alpha Centauri, Sirius, Procyon, Vega and Arcturus, close to the notable intersection (105, 120) in Length Sequences 1 and 3

The Distance of the Andromeda Galaxy

At a distance of 2.5 Mlyr the Andromeda Galaxy (M31) lies on a super-level (Level 115) in Length Sequence 1, as shown in Figure 15. The precise value of Level 115 is 2.54 Mlyr.

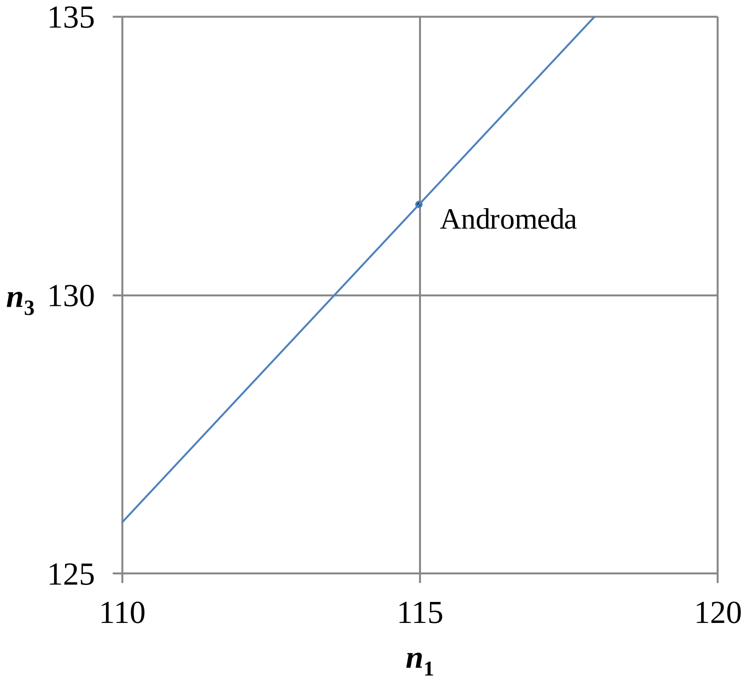

Figure 15: The distance from Earth of the Andromeda Galaxy on a super-level (Level 115) in Time Sequence 1

The Universe

At 13.8×10^9 years the age of the universe is located at the notable intersection (122.5, 140) in the time sequences, as shown in Figure 16. The precise value of Level 122.5 in Time Sequence 1 is 13.60×10^9 years.

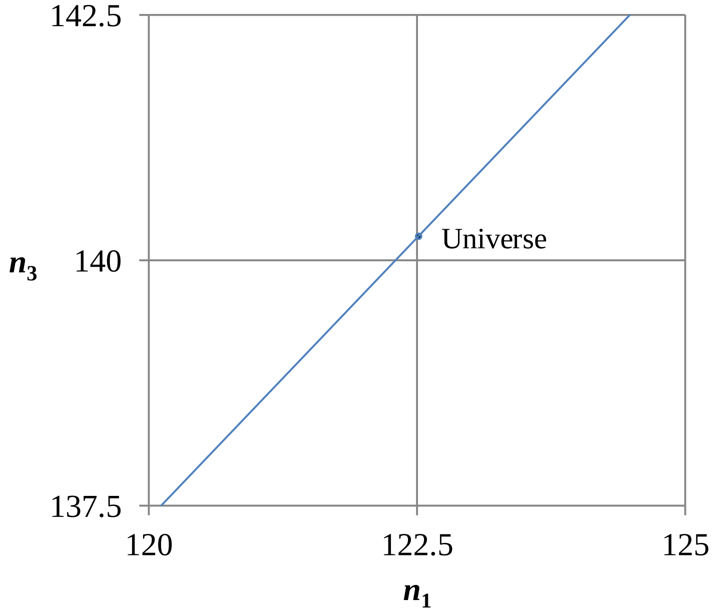

Figure 16: The age of the universe (13.8×10^9 years) at the notable intersection (122.5, 140) in Time Sequences 1 and 3

DNA

The helix diameter of B-DNA, the common form of DNA in cells, is 2.0 nm and lies on Level 52.5 (of value 2.03 nm) in Sequence 1 at the notable intersection (52.5, 60), as shown in Figure 17. Although not macroscopic, at a length scale greater than that of the Bohr radius (0.0529 nm) the helix diameter of B-DNA lies in the 'classical' realm.

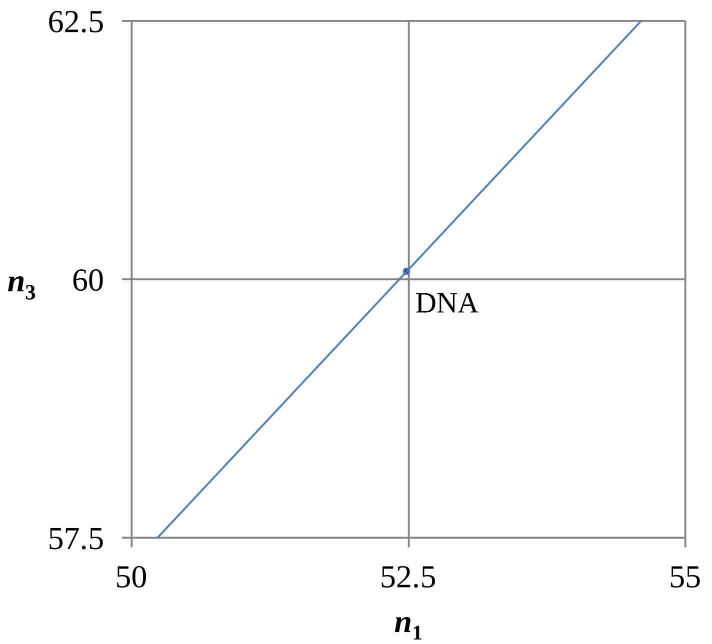

Figure 17: The helix diameter of B-DNA (2.0 nm) at the notable intersection (52.5, 60) in Length Sequences 1 and 3

Notable Length Scales

The length scales of the five notable intersections considered here are set out in Table 2. The length scales of the intersections lie in geometric sequence.

Intersection	Length Scale	Specific Parameters
(52.5, 60)	molecules	helix diameter of DNA
(70, 80)	human	metre
(87.5, 100)	Earth/Sun/Moon system	radius of Sun; mean distance from Earth of Moon
(105, 120)	brightest stars	distance from Earth of Vega
(122.5, 140)	universe	(age of universe) × c

Table 2: Scales of the notable intersections

Discussion

Macroscopic length and distance parameters adopt, on measurement, values that in Planck units are equal to integer and discrete fractional powers of π and e. In the length sequences the parameters lie on principal levels of integer level-number and sub-levels of half-integer, quarter-integer, eighth-integer, etc level-number. Parameters that lie on principal levels and low-order sub-levels tend to be those relating to objects that are conspicuous to the observer. On measurement, a parameter will take up a value consistent with the previously adopted values of other, probably more conspicuous, parameters.

If each parameter, essentially a number [9], is stored as a location in spacetime then certain locations may be favoured energetically. The most favoured locations in spacetime correspond to the scales of intersecting low-order sub-levels, principal levels and super-levels. The length scales of the 'notable' intersections form a natural hierarchy for the results of our observations.

References

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