The Act of Measurement II: Closer to Home

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The results are described of some simple home-based experiments to gauge the effect of the act of measurement on the values obtained. This paper is the companion of another, which showed that the act of measurement causes astronomical distances to adopt discrete values.

1 Introduction

The Quantum/Classical connection, characterised by the equation

$$2m^{-5} = R^2 \tag{1}$$

where m and R are measured in Planck units, maps astronomical distances R – all astronomical distances: not only the radii of astronomical bodies – onto sub-Planckian mass scales m on the mass levels and sub-levels[1] of two geometric sequences that descend from the Planck mass: Sequence 1 of common ratio 1/π and Sequence 3 of common ratio 1/e [1, 2, 3].[2] The mapping is bidirectional. The sequences may derive from the geometry of a higher-dimensional spacetime [4]. In 'The Act of Measurement I: Astronomical Distances' [1] we showed that the mass scales corresponding through (1) to the distances measured between Earth and the stars, and to various other measured distances, occupy the principal levels[3] and lower-order[4] sub-levels of Sequences 1 and 3. In addition, the measured distances themselves lie on the levels of Sequence 1c, which ascends from Planck scale with common ratio π, and Sequence 3c, which ascends from Planck scale with common ratio e. Bright astronomical bodies, such as Sirius, and bright astronomical objects, such as the sources of gamma-ray bursts, are often found to occupy or lie close to principal levels and lower-order sub-levels in one or both of the two types of sequence: 'quantum' (sub-Planckian mass scale) and 'classical' (in the case above, distance).

In this paper, the results are described of some simple home-based experiments to gauge the effect of measurement on the values obtained: objects are weighed, distances measured and steps counted. In the weighing experiments, a sub-Planckian 'quantum' mass m corresponds to the measured 'classical' mass M, in Planck units, through the Quantum/Classical connection in the form

$$2m^{-5} = M^2 \tag{2}$$

The calculated values of m are plotted on the levels and sub-levels of Sequences 1 and 3; the measured values of M are plotted on the levels and sub-levels of Sequences 1c and 3c. In the experiments measuring distance, the values of m calculated using (1) are plotted on the levels and sub-levels of Sequences 1 and 3; the measured values of R are plotted on the levels and sub-levels of Sequences 1c and 3c. In the step-counting experiment, the numbers of steps counted in journeys on foot are expressed as powers of π and e and the exponents are plotted on levels that number up from zero.

2018 CODATA recommended values of the Planck mass and Planck length are used in the calculations [5].

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[1] Half-levels, quarter-levels, eighth-levels etc

[2] Sequence 2 is of common ratio 2/π.

[3] Levels of integer level-number

[4] Sub-levels whose level-numbers are integer multiples of 2^{-n} where n is a small integer

2 Experiment 1: Weighing Books I

Ten books were weighed on a kitchen balance. The masses (in kg) of the books were 1.131, 1.638, 1.819, 0.646, 0.591, 0.810, 0.769, 1.335, 0.925 and 0.703. The weights were measured once only and no other books were weighed. The sub-Planckian mass scales corresponding through (2) to the masses of the books are plotted on the levels and sub-levels of (the 'quantum') Sequences 1 and 3 in Figures 1 and 2.

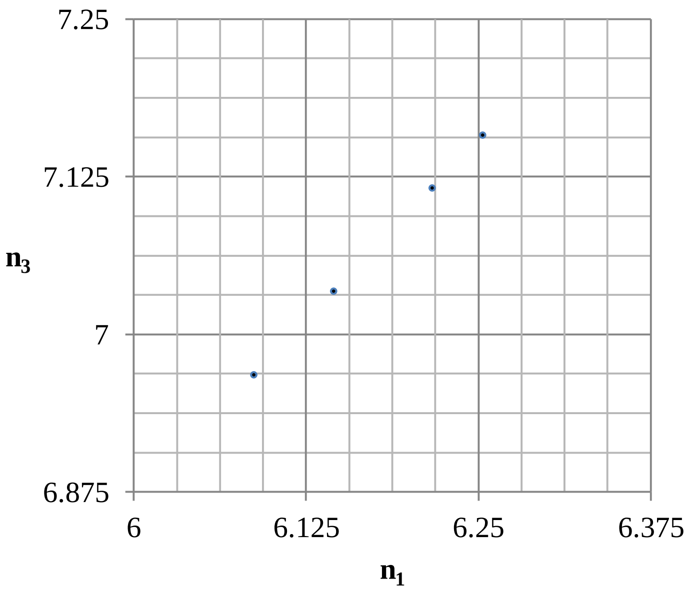

Figure 1: Sub-Planckian masses corresponding through (2) to the masses of the heaviest four books measured in Experiment 1 on the levels and sub-levels of Sequence 1 (common ratio 1/π) and Sequence 3 (common ratio 1/e). The sub-levels shown are of fifth order ($\frac{1}{32}$–levels) and lower order. The markers lie on a straight line because level-numbers in the two sequences are in constant ratio.

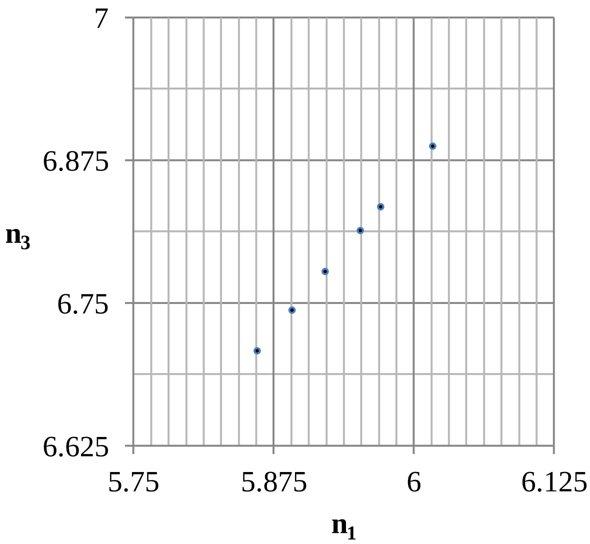

Figure 2: Sub-Planckian masses corresponding through (2) to the masses of the lightest six books on the levels and sub-levels of Sequences 1 and 3. The sub-levels shown are of sixth order ($\frac{1}{64}$–levels) and lower order.

There is a tendency for the books to occupy sub-levels of sixth and lower order in Sequences 1 and 3. The heaviest books occupy sub-levels of fifth order.

The masses of the ten books were next plotted on the levels and sub-levels of the 'classical' Sequences 1c and 3c.

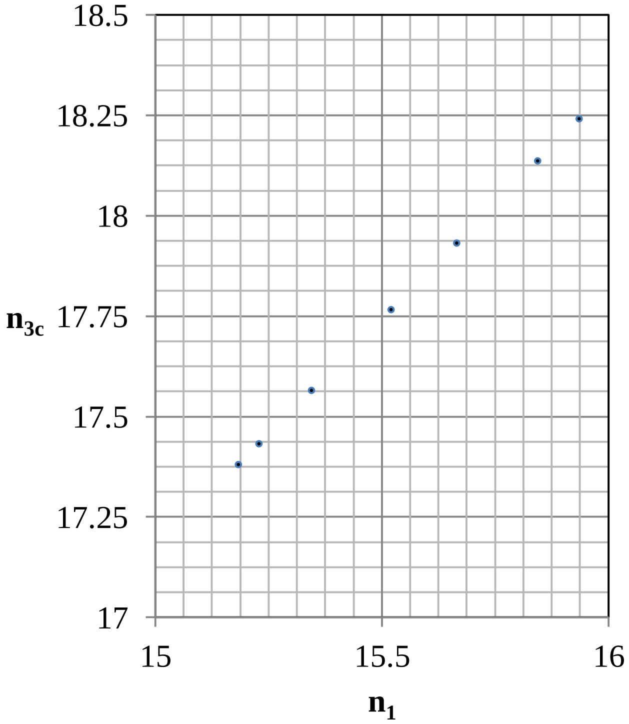

Figure 3: Masses of the heaviest seven books on the levels and sub-levels of Sequence 1c (common ratio π) and Sequence 3c (common ratio e). The sub-levels shown are of fourth order ($\frac{1}{16}$–levels) and lower order.

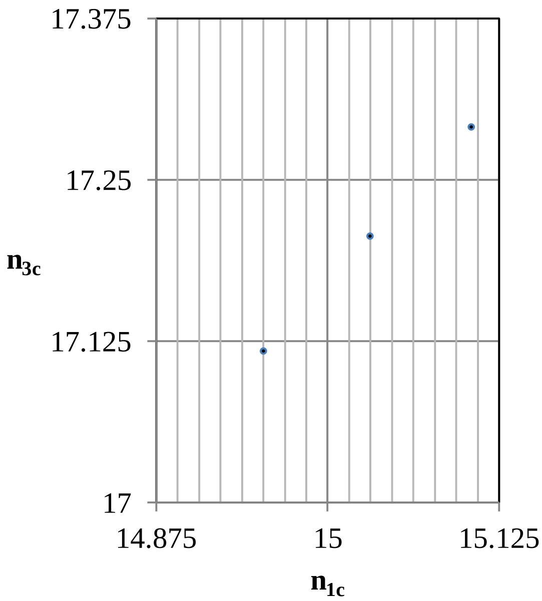

Figure 4: Masses of the lightest three books on the levels and sub-levels of Sequences 1c and 3c. The sub-levels shown are of sixth order ($\frac{1}{64}$–levels) and lower order.

There is a tendency for the books to occupy sub-levels of sixth and lower order in Sequences 1c and 3c. The heaviest books lie close to sub-levels of fourth order.

3 Experiment 2: Weighing Paint Cans

Ten partially-filled paint cans were weighed on the kitchen balance. The masses (in kg) of the paint cans were 0.726, 0.360, 0.178, 0.169, 0.571, 0.935, 0.871, 1.049, 2.690 and 2.534. The weights were measured once only and no other paint cans were weighed. The sub-Planckian mass scales corresponding through (2) to the masses of the paint cans are plotted on the levels and sub-levels of Sequences 1 and 3 in Figures 5 and 6.

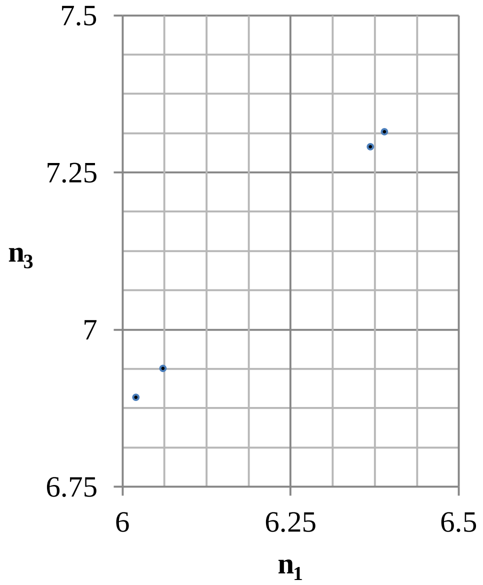

Figure 5: Sub-Planckian masses corresponding through (2) to the masses of the heaviest four paint cans on the levels and sub-levels of Sequences 1 and 3. The sub-levels shown are of fourth order ($\frac{1}{16}$–levels) and lower order.

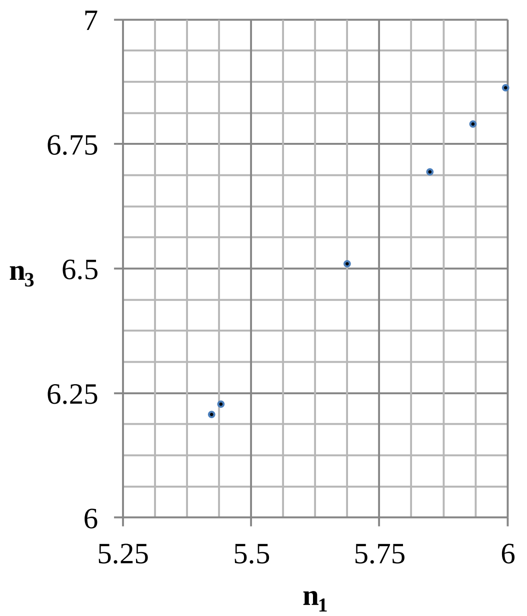

Figure 6: Sub-Planckian masses corresponding through (2) to the masses of the lightest six paint cans on the levels and sub-levels of Sequences 1 and 3. The sub-levels shown are of fourth order ($\frac{1}{16}$–levels) and lower order.

There is a tendency for the paint cans to occupy sub-levels of fourth and lower order in Sequences 1 and 3. All paint cans lie close to sub-levels of sixth-order and lower order.

Two paint cans are arranged about a fourth-order sub-level in the doublet configuration of the Planck Model, indicative of a broken symmetry [6]. It transpired that the two containers were essentially identical but contained different small amounts of paint.

The masses of the ten paint cans are plotted on the levels and sub-levels of Sequences 1c and 3c in Figures 7-9.

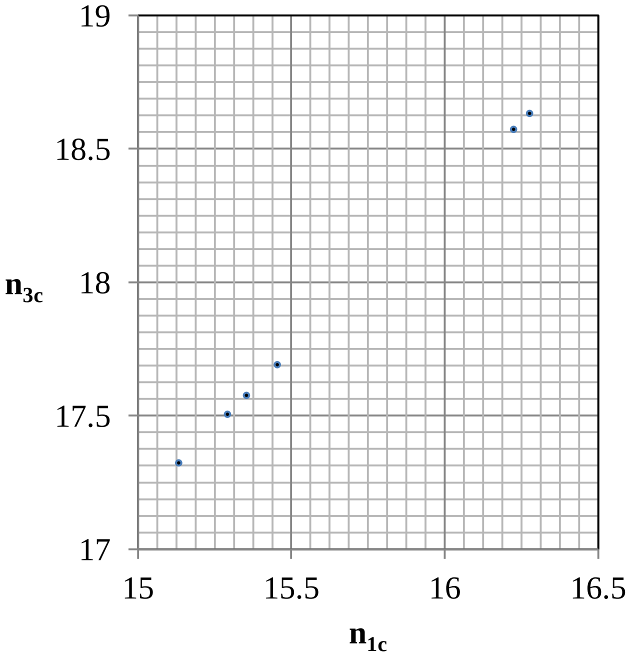

Figure 7: Masses of the heaviest six paint cans on the levels and sub-levels of Sequences 1c and 3c. The sub-levels shown are of fourth order ($\frac{1}{16}$–levels) and lower order.

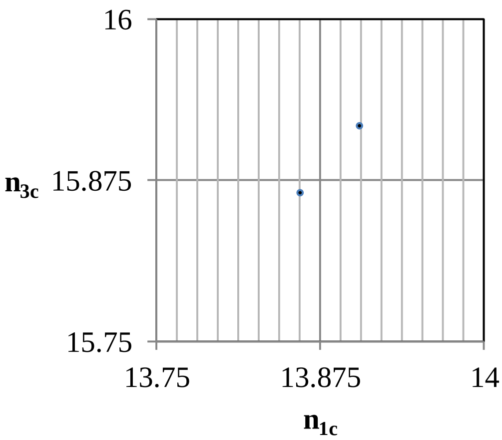

Figure 8: Masses of the lightest two paint cans on the levels and sub-levels of Sequences 1c and 3c. The sub-levels shown are of sixth order ($\frac{1}{64}$–levels) and lower order.

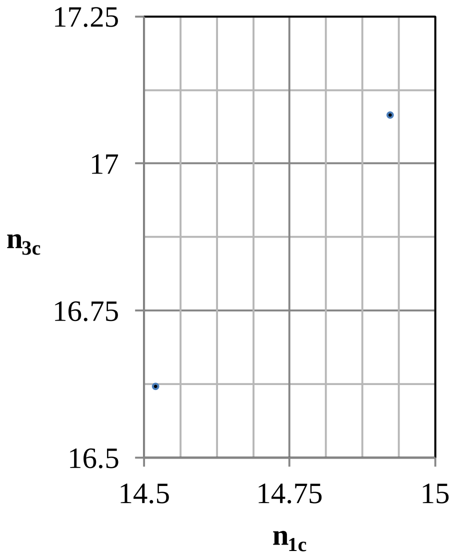

Figure 9: Masses of two of the lighter paint cans on the levels and sub-levels of Sequences 1c and 3c. The sub-levels shown are of fourth order ($\frac{1}{16}$–levels) and lower order.

There is a tendency for the paint cans to occupy sub-levels of sixth and lower order in Sequences 1c and 3c. The heaviest six cans occupy sub-levels of fourth and lower order.

4 Experiment 3: Measuring Distance I

Two 40 mm diameter hollow rubber balls were held in one hand and thrown onto a carpeted floor. The distance between the centres of the balls in their resting places was measured using a tape measure. Ten throws were made. The distances (in metres) measured between the balls were: 0.661, 0.151, 0.513, 0.279, 0.808, 0.370, 1.335, 0.616, 0.797 and 0.426. The mean distance measured was 0.530 m.

As in the weighing experiments there was no large difference in the pattern of level occupation in the quantum and classical sequences. For that reason we shall only show, in Figures 10-12, the occupation of levels in Sequences 1c and 3c.

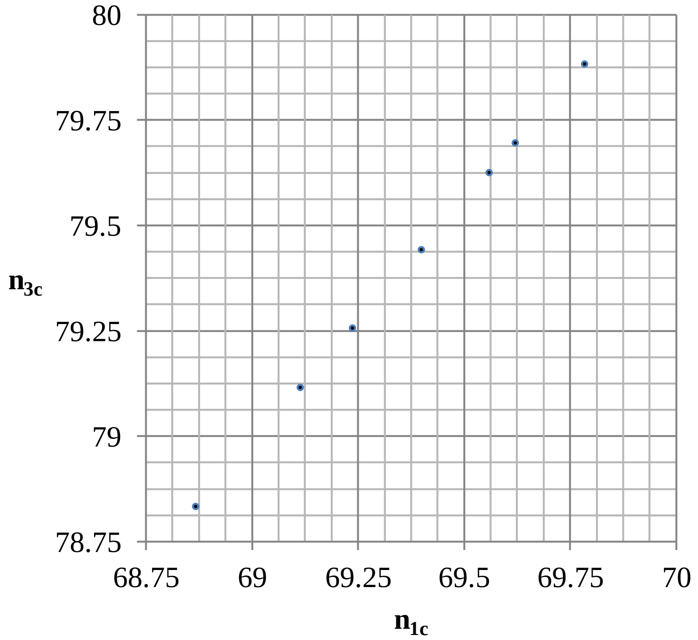

Figure 10: The medium distances measured in Experiment 3 on the levels and sub-levels of Sequences 1c and 3c. The sub-levels shown are of fourth order ($\frac{1}{16}$–levels) and lower order.

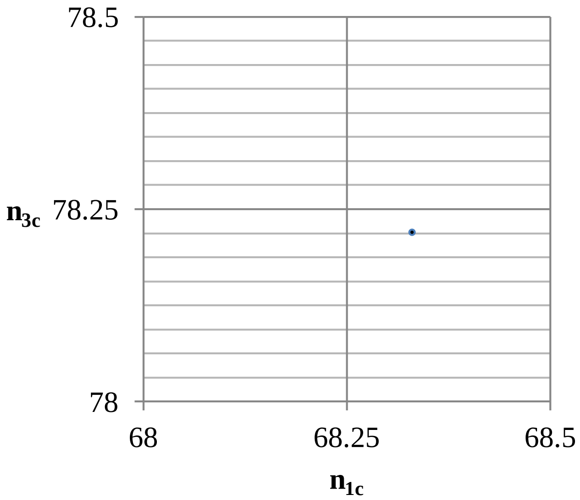

Figure 11: The shortest distance measured in Experiment 3 on the levels and sub-levels of Sequences 1c and 3c. The sub-levels shown are of fifth order ($\frac{1}{32}$–levels) and lower order.

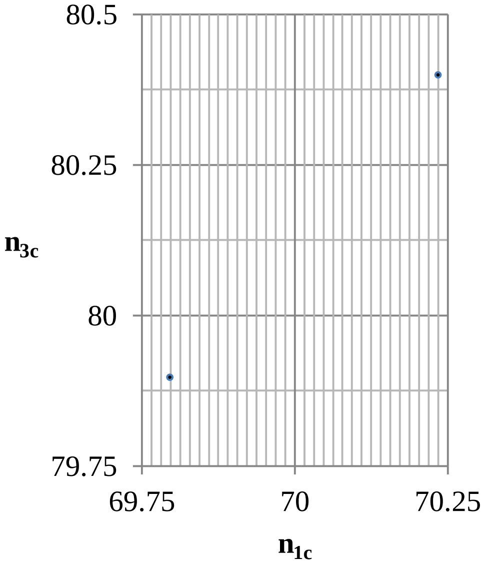

Figure 12: The longest distances measured in Experiment 3 on the levels and sub-levels of Sequences 1c and 3c. The sub-levels shown are of sixth order ($\frac{1}{64}$–levels) and lower order.

The distances between the two balls show a tendency to occupy sub-levels of fourth and lower order and all distances occupy sub-levels of sixth or lower order, which follows the pattern seen in the weighing experiments.

5 Experiment 4: Measuring Distance II

Experiment 3 was repeated. The distances (in metres) measured between the balls were: 0.656, 1.185, 1.618, 0.448, 0.194, 0.297, 0.511, 0.569, 0.927 and 0.563. The mean distance measured was 0.697 m. The distances measured are plotted on the levels of Sequences 1c and 3c in Figures 13-15.

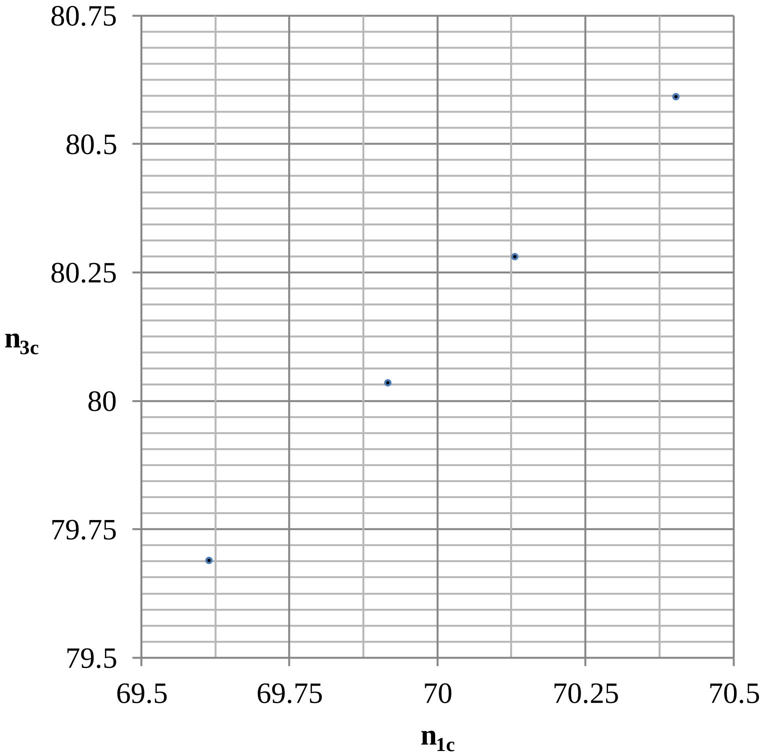

Figure 13: The medium distances measured in Experiment 4 on the levels and sub-levels of Sequences 1c and 3c. The sub-levels shown are of fifth order ($\frac{1}{32}$–levels) and lower order.

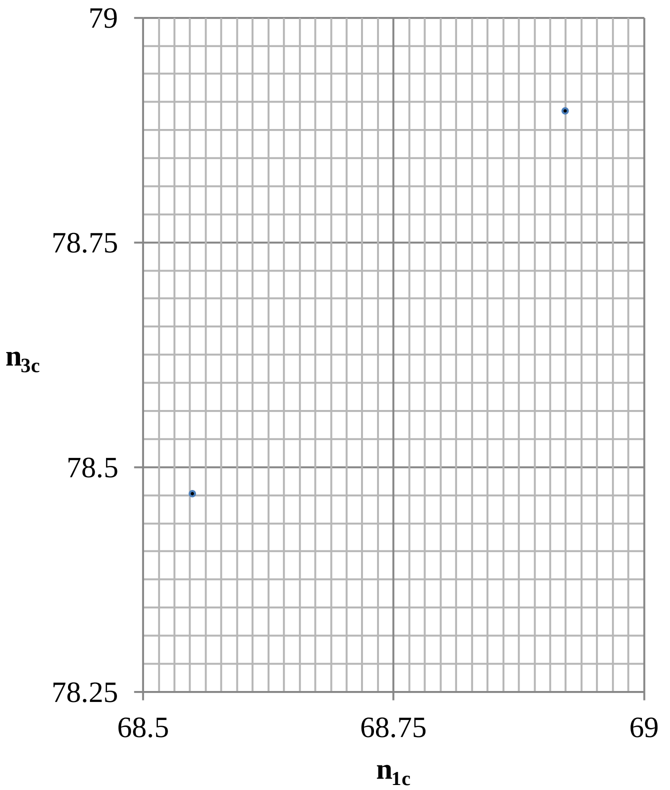

Figure 14: The shortest distances measured in Experiment 4 on the levels and sub-levels of Sequences 1c and 3c. The sub-levels shown are of sixth order ($\frac{1}{64}$–levels) and lower order.

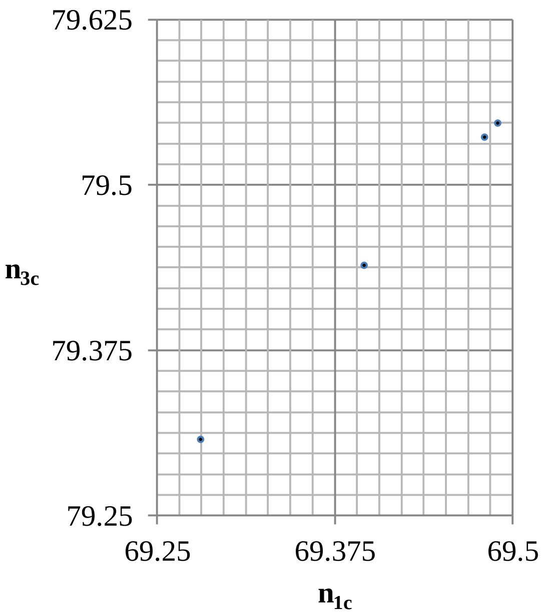

Figure 15: The longest distances measured in Experiment 4 on the levels and sub-levels of Sequences 1c and 3c. The sub-levels shown are of sixth order ($\frac{1}{64}$–levels) and lower order.

The sub-levels occupied are of fourth, fifth and sixth order.

6 Experiment 5: Counting Steps

The number of steps was counted for ten journeys on foot: three running and seven walking. The measurements were made using a 3D pedometer. During the period of several days over which the journeys took place the steps were not counted for any other journey. Details of the journeys undertaken are provided in Table 1.

Journey	Walk/Run	Route	Steps
J1	Run	The most frequently run personal standard route	5344
J2	Walk	Ad hoc	4837
J3	Walk	Ad hoc	5673
J4	Run	Frequently run personal standard route	6706
J5	Walk	Frequently walked outward journey	2721
J6	Walk	Return journey taking a different frequently walked route than J5	2545
J7	Walk	Ad hoc	1959
J8	Run	Frequently run personal standard route	8615
J9	Walk	Frequently walked personal standard route	5323
J10	Walk	Ad hoc	2669

Table 1: The journeys on foot and steps counted

The numbers of steps counted for the ten journeys are shown in Figures 16-18 as powers, n_π and n_e, of π and e, respectively.

The number of steps counted for journey J1 over the most frequently run route occupies a first-order sub-level, as shown in Figure 16. The numbers of steps counted for the other two runs occupy fourth-order sub-levels.

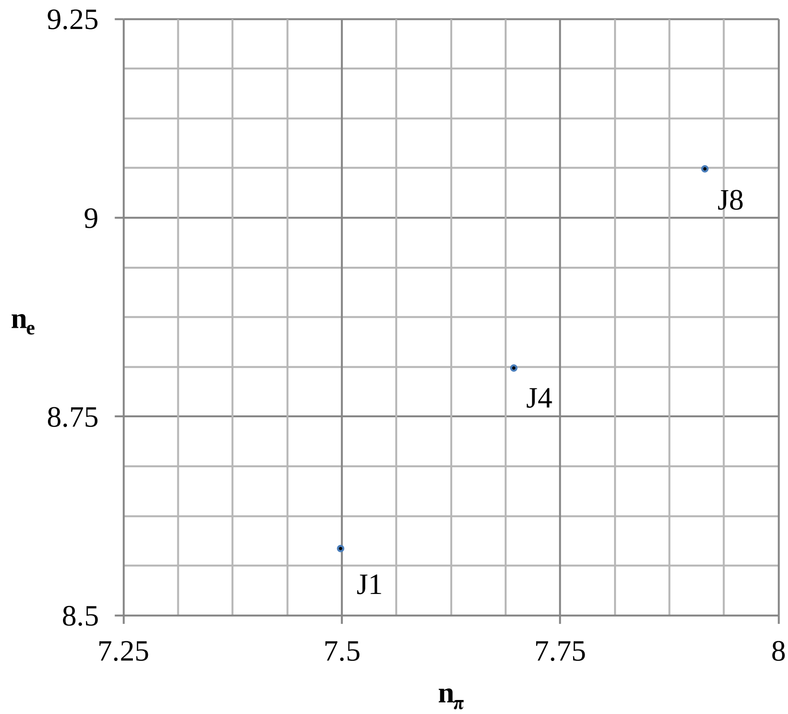

Figure 16: The numbers of steps counted for journeys J1, J4 and J8. The sub-levels shown are of fourth order ($\frac{1}{16}$–levels) and lower order.

The numbers of steps counted for the seven walks occupy sub-levels of sixth-order and lower order, as shown in Figures 17 and 18.

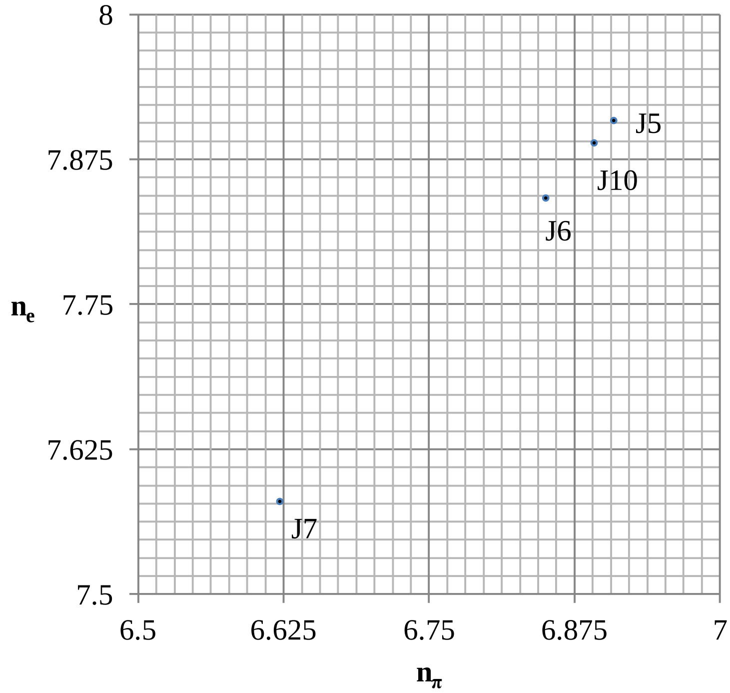

Figure 17: The numbers of steps counted for journeys J5, J6, J7 and J10. The sub-levels shown are of sixth order ($\frac{1}{64}$–levels) and lower order.

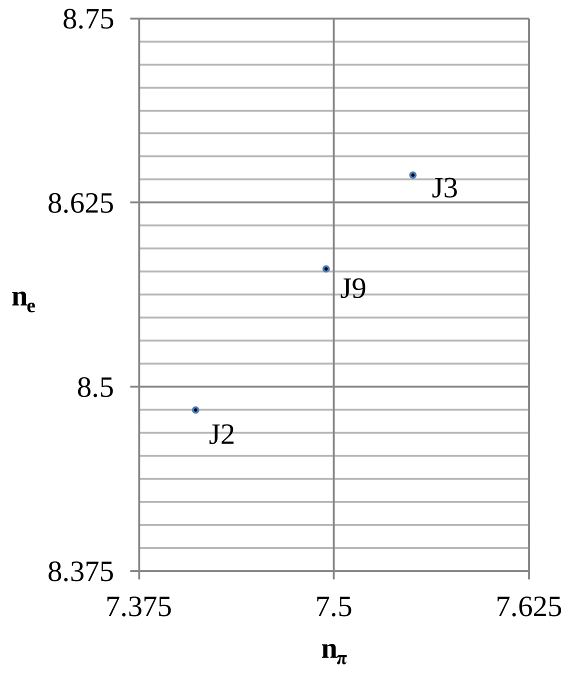

Figure 18: The numbers of steps counted for journeys J2, J3 and J9. The sub-levels shown are of sixth order ($\frac{1}{64}$–levels) and lower order.

There may be some correlation between familiarity of a route and lower-order sub-level occupation: J1 lies on a first-order sub-level; J4 and J8 lie on fourth-order sub-levels; J9 surprisingly lies close to the first-order sub-level occupied by J1; and J5 and J6 are symmetrically arranged about a third-order sub-level. However, J7, which was a short unplanned meandering walk, also occupies a third-order sub-level.

7 Experiment 6: Weighing Books II

Another person, who had not been given any information about the work described here, was asked to weigh ten books of their choosing at another location. The books were weighed on a kitchen balance. The masses (in kg) of the books were: 1.265, 0.881, 0.529, 0.643, 0.623, 0.532, 0.745, 0.668, 0.326 and 0.456.

The masses of the ten books have been plotted on the levels and sub-levels of Sequences 1c and 3c, as shown in Figures 19 and 20.

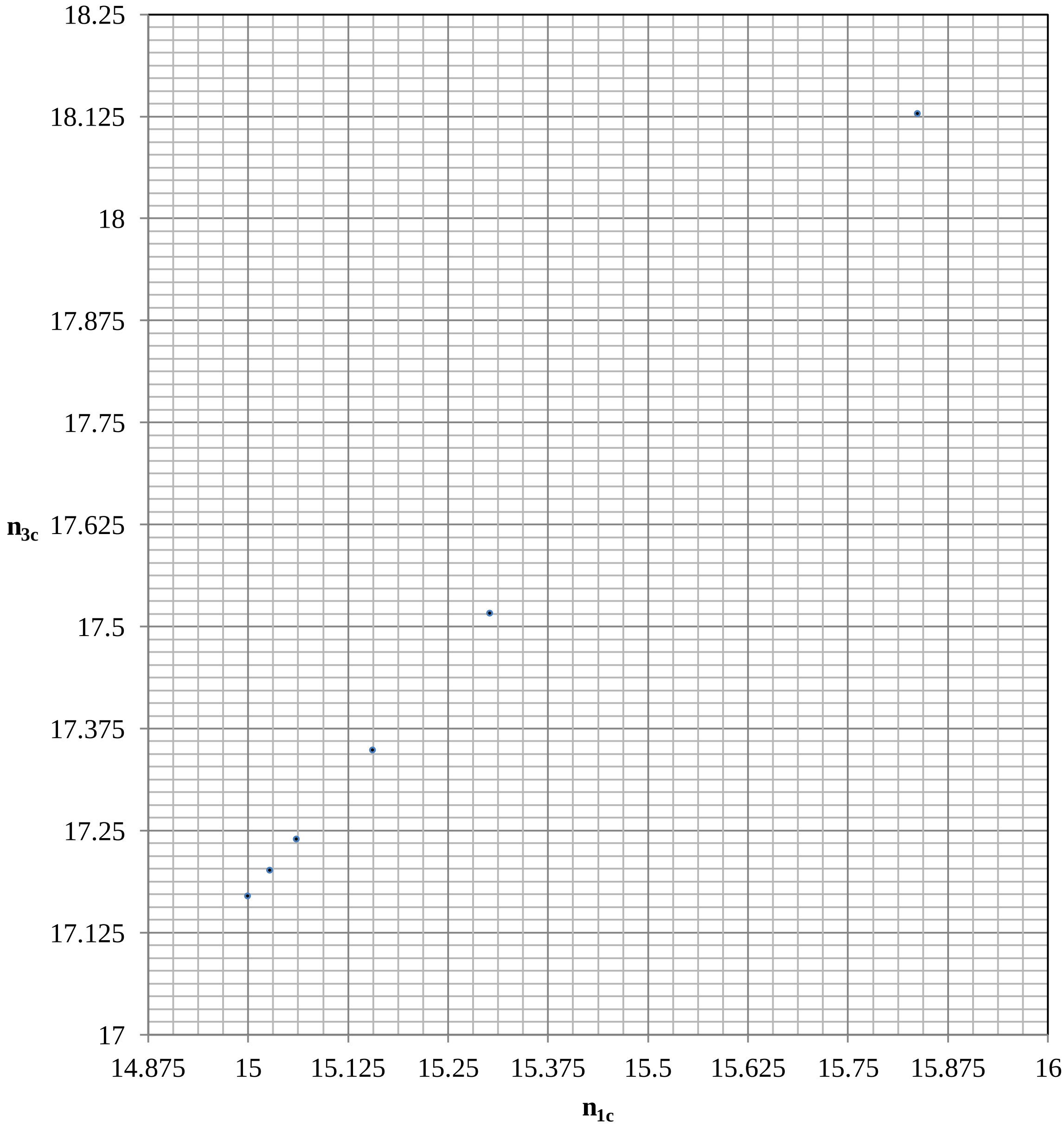

Figure 19: Masses of the heaviest six books measured in Experiment 6 on the levels and sub-levels of Sequence 1c and Sequence 3c. The sub-levels shown are of sixth order ($\frac{1}{64}$–levels) and lower order.

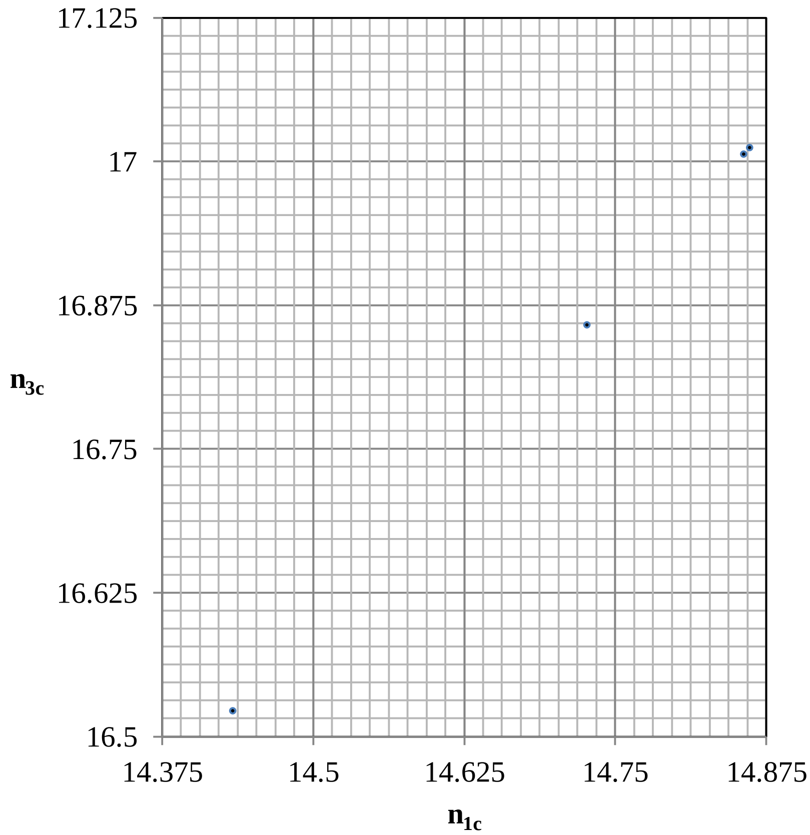

Figure 20: Masses of the lightest six books measured in Experiment 6 on the levels and sub-levels of Sequence 1c and Sequence 3c. The sub-levels shown are of sixth order ($\frac{1}{64}$–levels) and lower order.

The books occupy sub-levels of sixth and lower order in Sequences 1c and 3c.

8 Discussion

The act of measurement perturbs the system of the observer and the observed and causes the parameter being measured, say the mass of an object or the distance between two objects, to adopt a value taken on a probabilistic basis from a large number of possible values that lie on the levels and sub-levels of the quantum and classical sequences described here. The most probable values are those that occupy principal levels and the lower-order sub-levels. All adopted values lie close to sub-levels of sixth and lower order.

In all the experiments described the unit of measurement is the natural unit: the Planck unit when measuring mass or the distance between objects; and the step when measuring journeys on foot.

In [1], the distances of bright astronomical bodies and objects, and the corresponding sub-Planckian mass scales, were shown to lie on the low-order levels of the two types of sequence: classical and quantum. In the step-counting experiments described here the familiarity of the observer with the route taken may have had some bearing on the value adopted when the measurement was made.

References

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