

Quantisation in stable gravitational systems _ more objects

R. Wayte.

29 Audley Way, Ascot, Berkshire, SL5 8EE, England, UK

Email : rwayte@googlemail.com

Research article: submitted for publication 26 November 2025.

Abstract. The original article on quantisation in gravitational systems has been extended to cover the latest data on Trans-Neptunian Objects, the hypothetical Planet-Nine, and the Oort cloud. Then planet-nine might orbit at a semimajor axis around 703AU, while the Kuiper belt is around 44AU and the Scattered Disk Objects are fitted broadly around 78AU and 175AU, and 700AU. The Hills cloud fits harmonics from 2,800AU up to 17,600AU; and the outer Oort cloud fits further harmonics up to 180,000AU. Quantisation of orbits is a weak influence so objects may remain unstabilised yet commensurable with neighbouring objects.

Keywords: Quantisation, planets, solar system.

PACS Codes: 96.12.De, 04.60.Bc

1. Introduction

A great deal of knowledge on the Solar System has been gathered over the past forty years, so it is now possible to add new results to the original article on quantisation effects, (Wayte, 1982). Of current interest especially is the hypothesised Planet-Nine which like the other planets may have been subject to a quantising force governing its orbit in the Solar System. The Kuiper Belt, Scattered Disk Objects, and the Oort Cloud have been observed in great detail, so quantisation of their orbits can be investigated. Normal gravity is in control of all orbits but the weak quantising forces help concentrate material in particular stable orbits.

2. Planet-Nine

When investigating the apparent perturbation of nearby objects by a possible Planet-Nine, the analysis by Brown, Batygin et al (2024 and references therein) has indicated an orbit of semimajor axis between 400 and 800AU. Likewise, the detailed analysis by Millholland and Laughlin (2017) on postulated mean-motion resonances with a Planet-Nine has produced a semimajor axis of 654AU. Other work by Phan et al (2025) discovered images from far-infrared surveys by IRAS and AKARI, which can be interpreted as a Planet-Nine orbiting at a semimajor axis between 500 and 700AU.

Given these three estimates for the semimajor axis of a Planet-Nine, we shall make use of our original article and employ Eq.(3b), Eq.(8b), and Figure 1 therein to see if any quantisation rules can be derived to specify an orbit size. Thus, the gravitational de Broglie-type equations give

$$[2\pi r = N(\hbar/m_G v_\varphi)] \quad \text{or} \quad [v_\varphi r = (GMr)^{1/2} = N(\hbar/m_G)], \quad (2a)$$

where m_G is the effective gravitational guidewave source mass such that

$$[m_G \times \left(\frac{e^2}{Gm_e^2} \right)^{1/2} = 250m_e = m_i] \quad , \quad (2b)$$

where m_e is the electron mass. This m_i is understood to represent the (Yukawa) mesons constituting the nuclear field in the planet's atoms acting as real guidewave sources. The guiding force is weak and stabilises an orbit by fitting Eq.(2a) for integer N: there may be unoccupied orbits but none are forbidden.

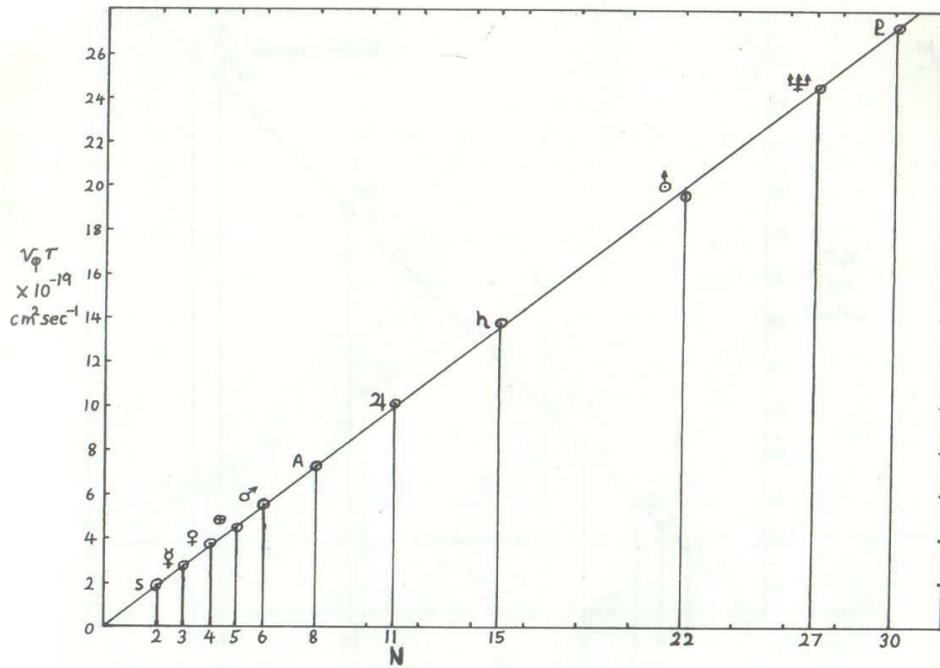


Fig. 1. The planetary system. Specific angular momentum versus quantum number.

Fig.1 From original article: showing how the planets obey Eq.(2a).

For Neptune at semimajor axis 30.1AU, the quantum number was found to be ($N = 27$), so for a Planet-Nine orbiting at semimajor axis 654AU it would be around ($N \sim 126$) to fit on the extrapolated straight line of Figure 1. But this N value appears to have no special significance, being so much greater than the values for planets. However, if the guidewaves were emitted by electrons rather than nuclear field mesons within Planet-Nine, then mass m_{Ge} could represent the electron's gravitational guidewave source mass, given by

$$m_{Ge} = m_e \times \left(\frac{e^2}{Gm_e^2} \right)^{-1/2}. \quad (2c)$$

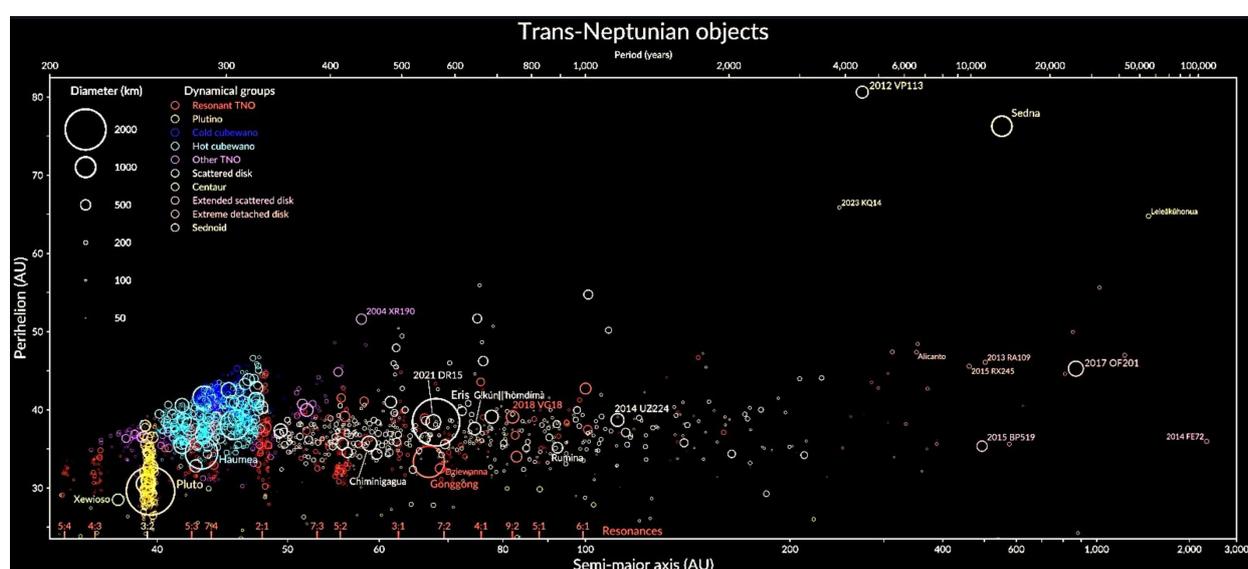
And using Eq.(2a), we can propose for Planet-Nine a quantised semimajor axis of ($r_9 \sim 703$ AU) which satisfies a fundamental equation

$$(GMr_9)^{1/2} = N_e(\frac{1}{2}\hbar/m_{Ge}), \text{ for } (N_e = 1). \quad (2d)$$

The coefficient ($\frac{1}{2}$) indicates that half a gravitational de Broglie wavelength fits around the orbit because intensity is operating rather than amplitude: there are 2 intensity peaks per wavelength.

By making N_e in Eq.(2d) an integer or fraction, we can define harmonic orbits in the Oort Cloud and sub-harmonic orbits in the Kuiper Classical Belt and Scattered Disk as follows. These objects will satisfy Eq.(2d) for guidewave emission from their interior electrons, independent of Planet-Nine, although commensurabilities may exist.

Figure 2 is very helpful in showing the distribution of known trans-Neptunian objects.



Retrieved from <https://en.wikipedia.org/wiki/File:TNOs-wide-view.svg> with permission, Thunkii. **Fig. 2** Distribution of trans-Neptunian objects, with semimajor axis on the horizontal, and perihelion on the vertical axis. Scattered disc objects occupy the wide horizontal region in grey and purple, while objects that are in resonance with Neptune are in red. Extreme trans-Neptunian objects and sednoids are in pink, brown, and yellow. Finally, the classical Kuiper belt is in blue.

3. Kuiper Belt

The main torus body of the Kuiper belt is near to Neptune, so we shall first consider the original analysis for Neptune which yielded quantum number ($N = 27$) for its 30.1AU semimajor axis. Then, the main Kuiper belt body lies between semimajor axis 39.5AU where ($N = 31$) and 48AU where ($N = 34$). Plutinos also concentrate around 39.4AU. However, none of these quantum values appear to give a reason for the particular location of the Kuiper belt.

Fortunately, the new electronic guidewave mechanism described above could have been active in positioning the Kuiper belt. That is, Eq.(2d) yields subharmonic ($N_e = 1/4$) for the belt centre of gravity at 44AU, so, electrons in the belt material emit gravitational guidewaves which control their own trajectories. The belt can have some width because the control intensity decreases slowly either side of 44AU. At the same time, the nuclear field mesons will also contribute to guiding stability, as mentioned above with ($N = 31 - 34$).

Remarkably, the Asteroid belt is scattered around semimajor axis 2.75AU which fits subharmonic ($N_e = 1/16$), as well as ($N = 8$) on Figure 1.

4. Scattered Disk

Scattered Disk Objects exist from the Kuiper Belt out to around 200AU with apparent concentration broadly around 78AU, which corresponds to subharmonic ($N_e = 1/3$) in Eq.(2d). A significant density of objects also exists broadly around semimajor axis 175AU which corresponds to subharmonic ($N_e = 1/2$). The Detached Objects are found roughly between 50AU and 1000AU, so they can benefit from guiding stability by satisfying Eq.(2d) for ($N_e = 1, 1/2, \text{ and } 1/3$).

All these objects obey Eq.(2d) for their own stabilising electronic guidewaves, independent of Planet-Nine, although normal gravity may produce commensurabilities between them all.

5. Oort Cloud

The inner part of the Oort cloud, known as the Hills cloud, is much denser than the outer Oort cloud and is thought to be toroidal in shape extending from around 1000AU to 20,000AU from the Sun. This range satisfies Eq.(2d) very well for harmonic orbits, which are quantum stabilised such as: ($N_e = 2$) for the material around 2,800AU; ($N_e = 3$) for 6,300AU; ($N_e = 4$) for 11,200AU; and ($N_e = 5$) for material around 17,600AU. Orbits satisfying integer values of N_e are preferred but fractional values may also be active, such as: ($N_e = 3/2$) for the material around 1,600AU; ($N_e = 5/2$) for 4,400AU; and ($N_e = 7/2$) for 8,600AU; etc. These stabilised orbits are not sharply defined because the guiding force slowly loses coherence either side; so, the spaces between these orbits may contain unstabilised orbiting material.

The outer Oort cloud is thought to take a spherical shell shape around the whole solar system, extending from 20,000AU to 200,000AU from the Sun. Stabilised orbits of objects within this cloud which satisfy Eq.(2d) could have harmonic values of N_e from 6 to 16, and the spaces between these could fill with unstabilised orbiting material, which may be independently commensurable.

6. Conclusion

The original article of 1982, on quantisation of planetary orbits, has been reconsidered to include the latest data on Trans-Neptunian Objects, the hypothetical Planet-Nine, and the Oort cloud. Theory developed therein for the planets has been applied to these larger orbits by replacing the nuclear field meson sources with electron guidewave sources. Planet-nine needed this change in order to calculate a good fit for a semimajor axis around 703AU. The Kuiper belt at 44AU then fitted the fourth subharmonic frequency. The Scattered Disk Objects around 75AU fitted the third subharmonic, and those around 175AU fitted the second subharmonic. The Detached Objects fitted these subharmonics as well as the fundamental frequency. The Hills cloud fitted the second harmonic at 2,800AU up to the fifth harmonic at 17,600AU, and the outer Oort cloud further fitted harmonics up to the sixteenth at 180,000AU. Orbit stabilisation is weakly implemented, so objects may exist unstabilised between the stabilised objects, yet commensurable with them due to normal gravity. In conclusion, these six added entities have been given status in a controlled Solar System, rather than being a jumble of residue.

Acknowledgements

I would like to thank Imperial College Libraries.

References

- Brown, M E., Holman, M J., and Batygin, K. 2024, AJ, 167, 146
- Millholland, S., and Laughlin, G. 2017, AJ, 153, 91
- Phan, T L., et al. 2025, Pub Astron Soc Australia, 42, e064
- Wayte, R. 1982, The Moon and the Planets, 26, 11