Is There Someone Else..?

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What Are We Even Looking For

- Mass: 5–10 $M_{\oplus}$
- Orbital distance: 400–800 AU
- Orbital period: 10,000–20,000 years

Figure 1 - Pluto Cartoon

Figure 2 - Two scientists

Figure 3 - Mike Brown's Personal Website

Figure 4 - Caltech professor Mike Brown and assistant professor Konstantin Batygin

Why We Think It Is There

1. Clustering of distant TNO orbital directions
2. Collective tilt (~20°) of those orbits out of the solar system plane
3. Upside-down orbits (100–120° inclination) at large distances
4. TNOs’ orbits cross Neptune’s orbit

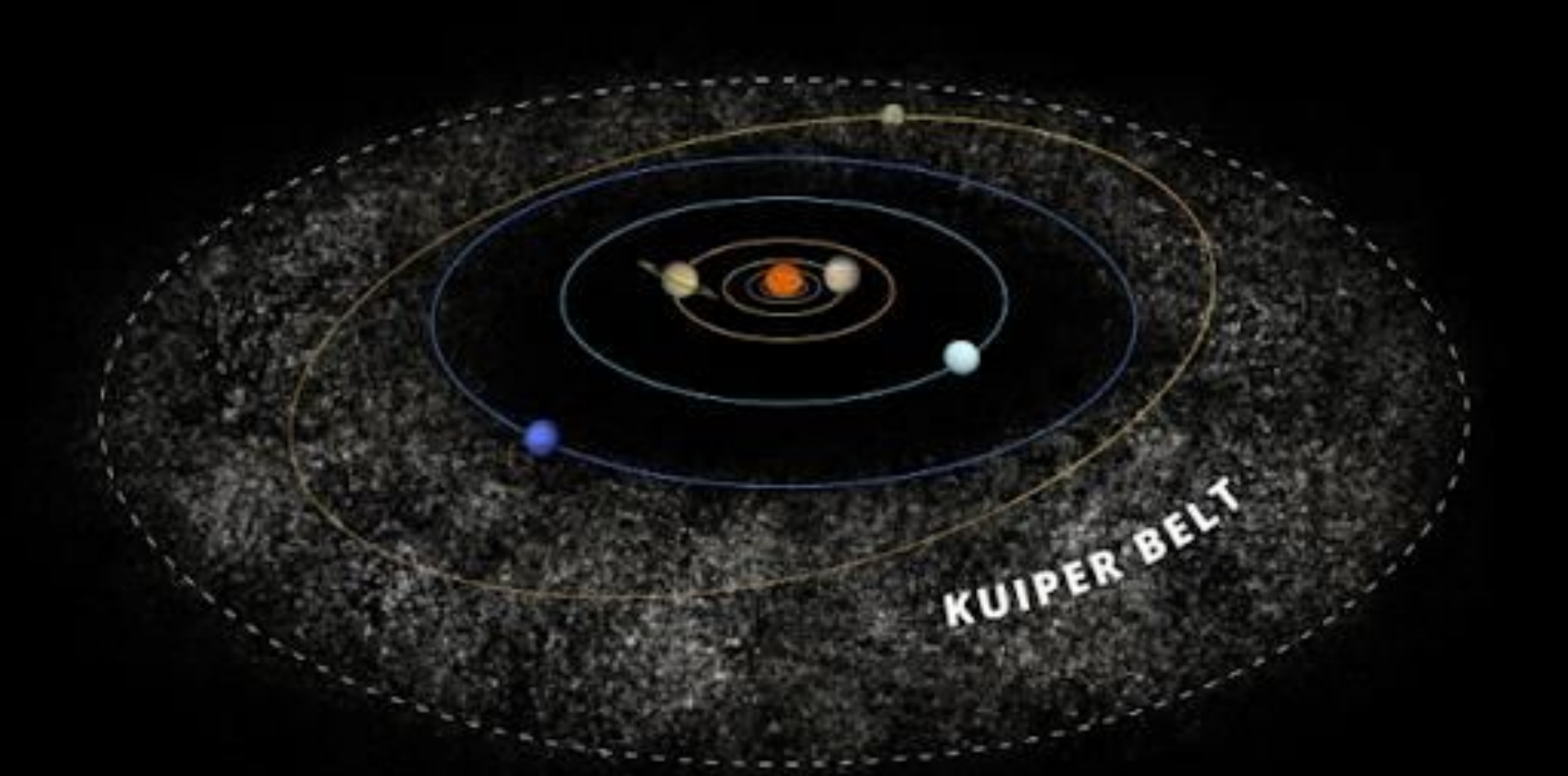

Figure 5 - The Illustration of Kuiper Belt

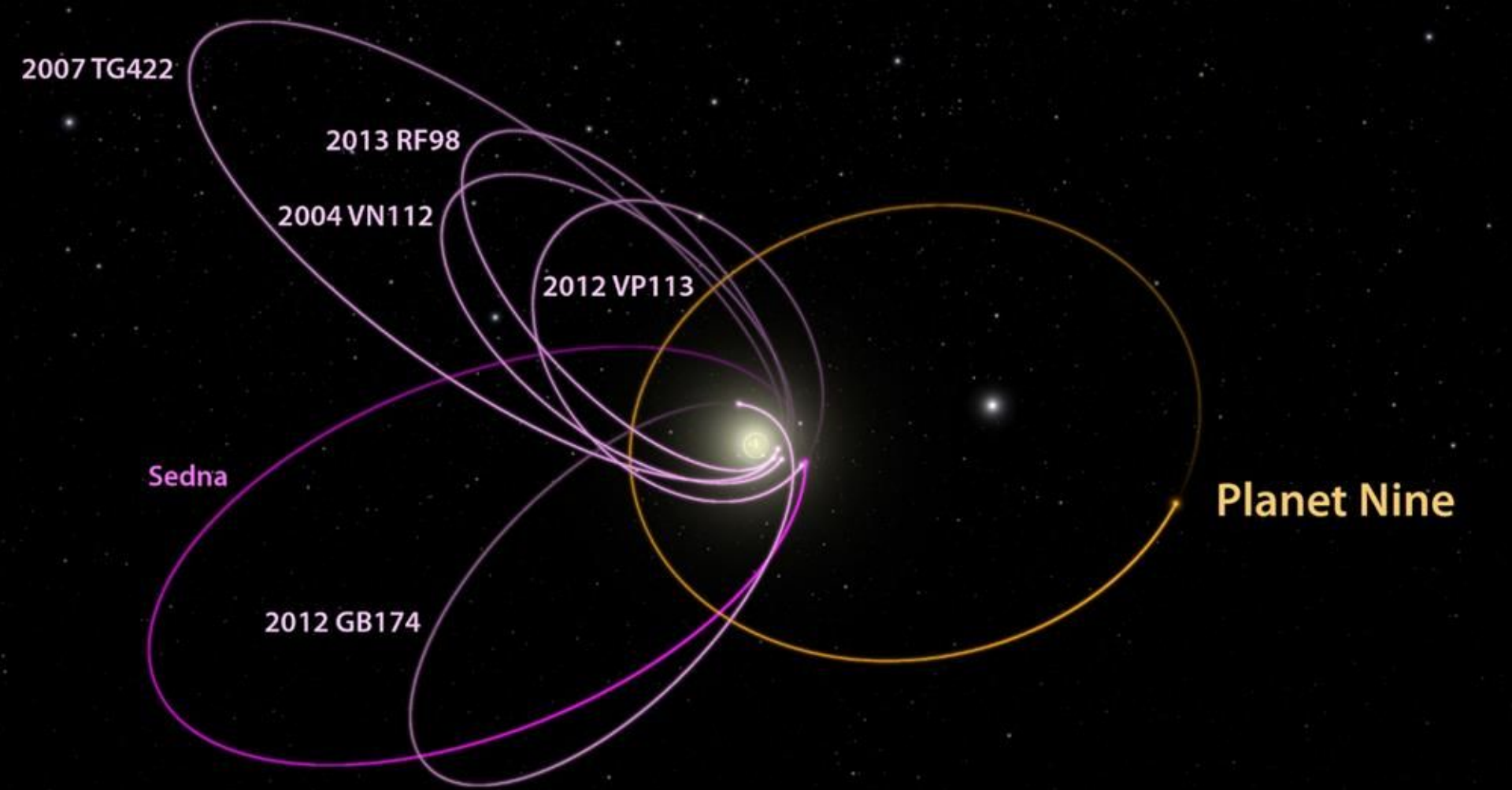

Figure 6 - The Illustration of TNOs Orbits

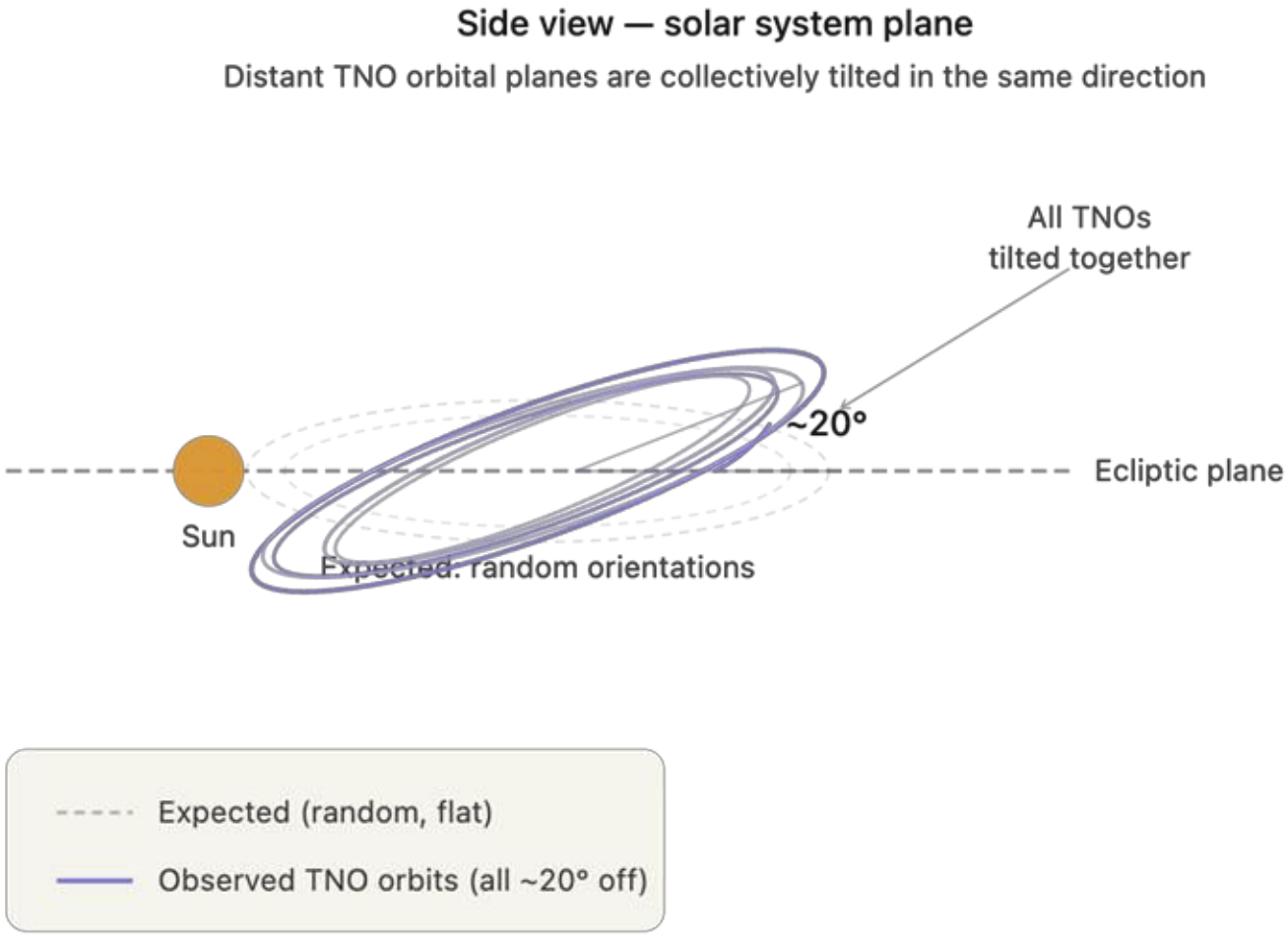

Figure 7 - The Illustration of TNO's Tilted Orbits

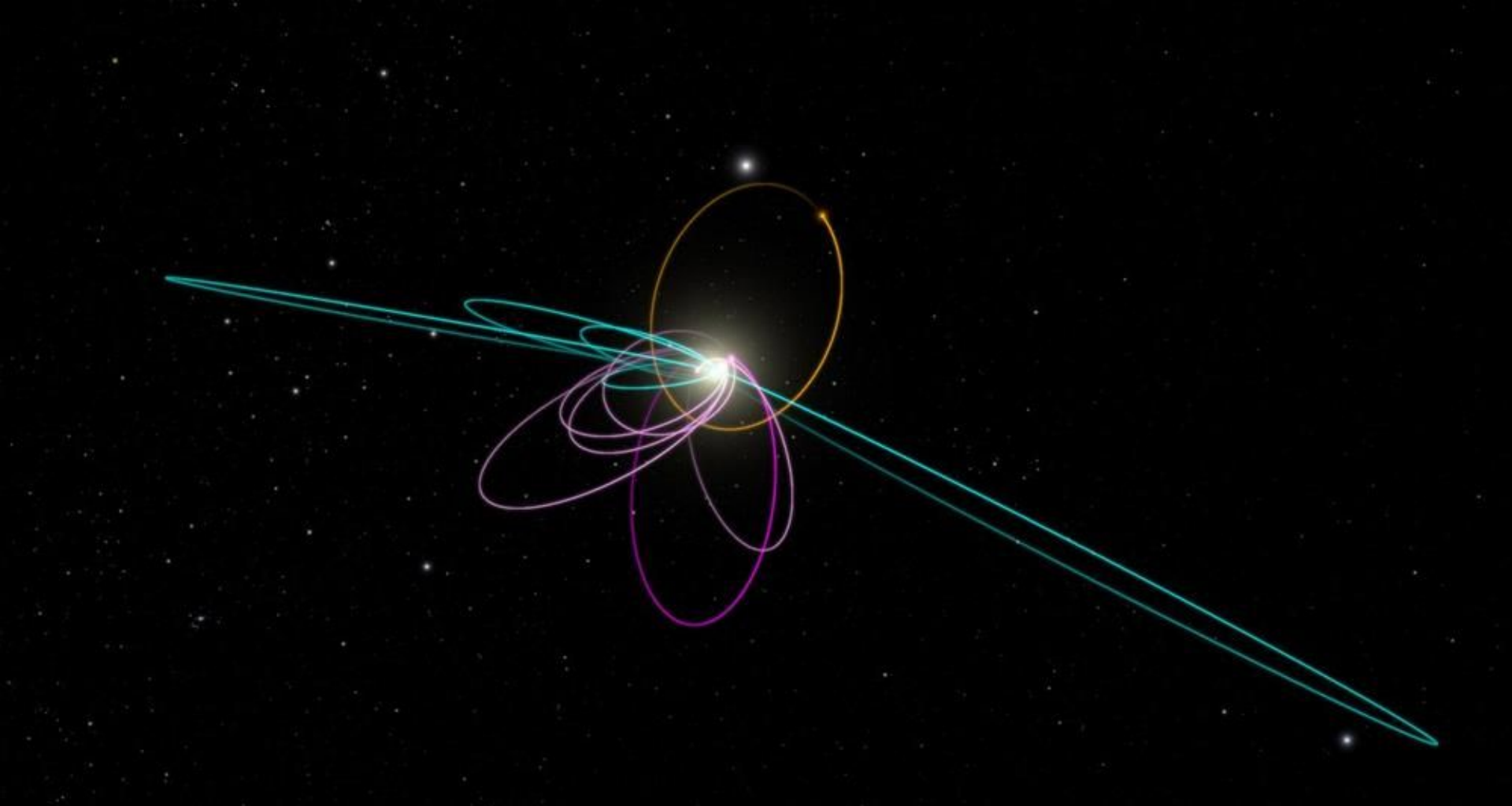

Figure 8 - The Illustration of TNO's Perpendicular Orbits

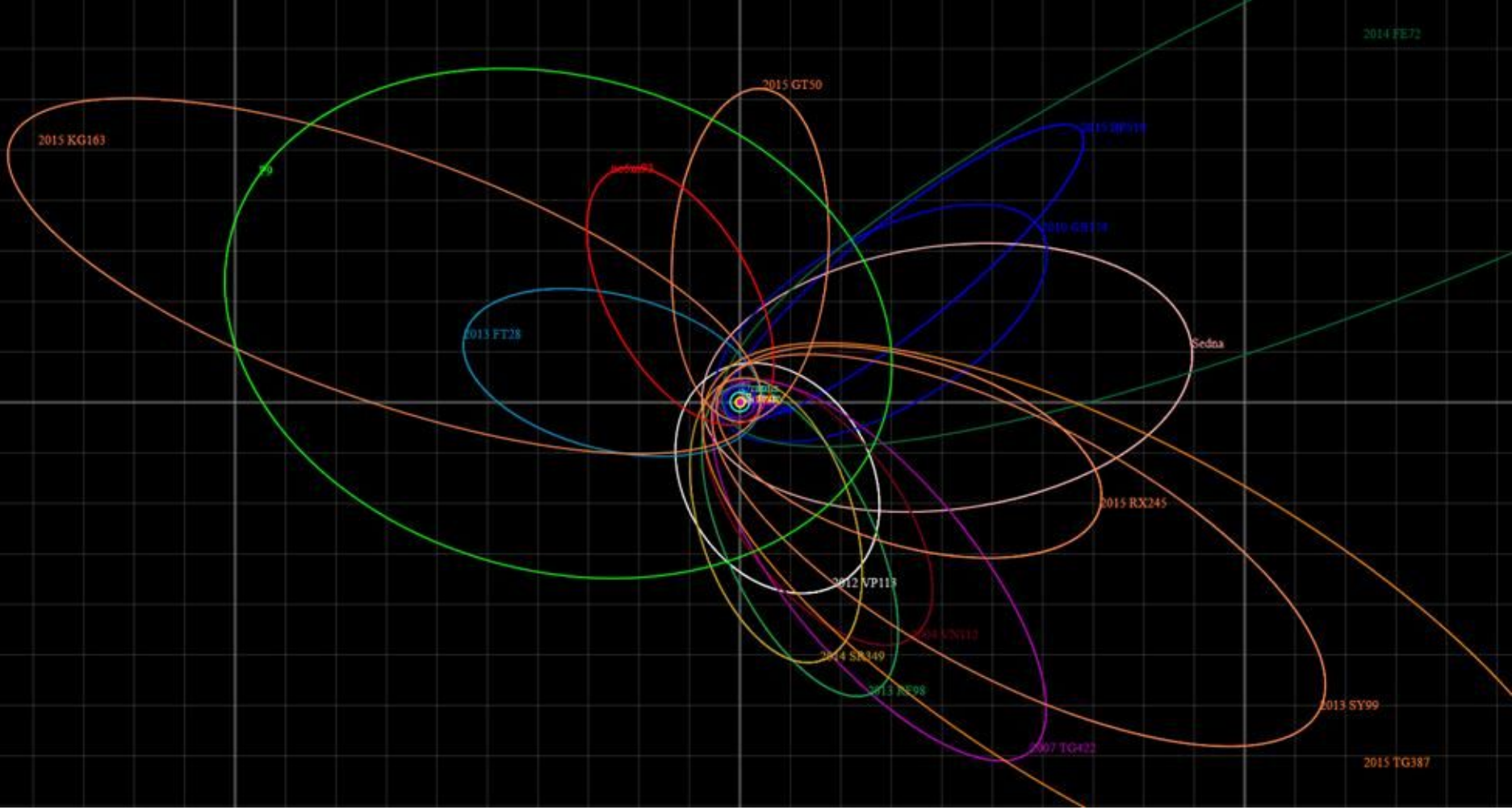

Figure 9 - The Illustration of other TNO's Orbits

Alternative Explanations

Primordial Black Holes

- Stephen Hawking proposed the existence of very small (10μg) black holes distributed throughout the universe
- These black holes may eat larger objects over time and form Earth-mass black holes
- One of these could have been captured by the Sun in a distant orbit

Primordial Black Hole Image (actual size)

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Inclination instability in a massive disc

- Inclination instability in a distant massive Zderic-Madrigan belt would cause spontaneous self-organisation due to it's self-gravity
  - Such a ZM belt would have to have a mass of 1-10 Earth masses and have existed for at least one billion years

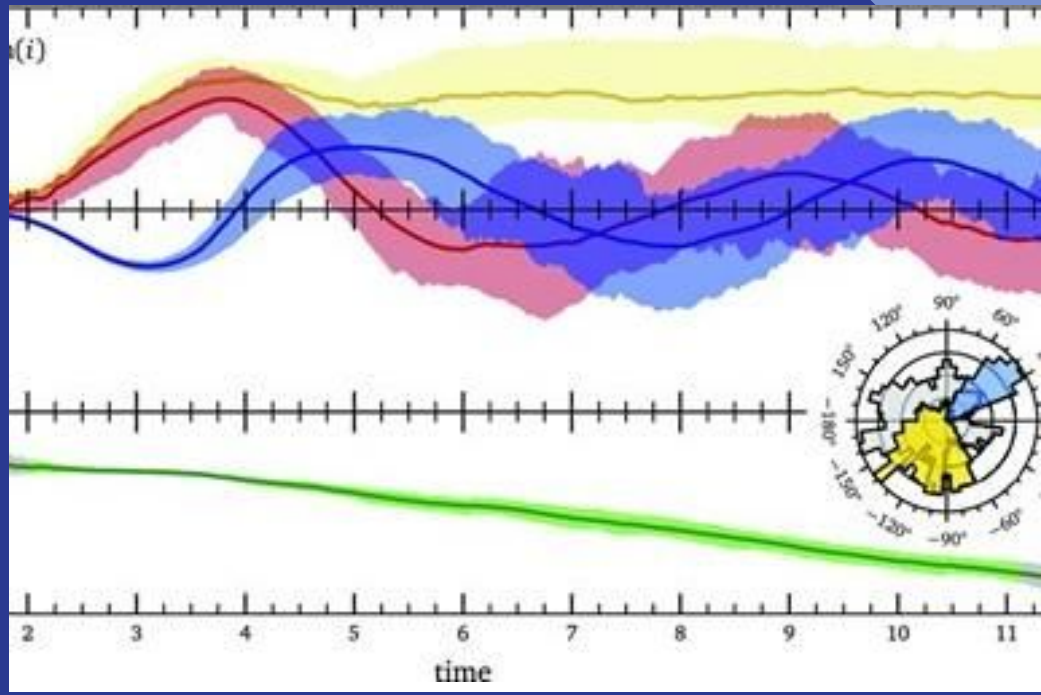


Figure 10: graph of inclination instability in massive belt

Shepherding by a massive disc

- Shepherding by a massive disc – like the Kuiper belt – could cause an alignment of trans-Neptunian objects and a stabilisation of eccentricity agains the influences of massive planets
  - Unknown if the mass of the Kuiper belt is sufficient (1-10 Earth masses)

Figure 5: Illustration of Kuiper Belt

Modified Newtonian Dynamics (MOND)

This particular implementation of a modification of Newtonian gravity and it's relativistic counterpart TeVeS proposes that gravity works differently on large scales

In particular, ETNOs and TNOs would have their orbital inclinations influenced via MOND's "external field effect" by the galactic plane and the centre of the galaxy

Extraordinary claims require extraordinary evidence, and while some aspects of MOND and TeVeS fit observational data, others do not.

Temporary clustering

- Astronomer Cory Shankman included Planet 9 in simulations with clones of 15 different known TNOs that Shepard, Trujillo, Brown, and Batygin posit are influenced by Planet 9
- These simulated objects behaved differently than their observed counterparts
  - While the objects did orbit opposite Planet 9, as predicted, there was no clustering of inclinations observed, and the perihelia fluctuated smoothly between 50 and 70 AU where none had been observed
  - Several objects were also violently ejected from the solar system
- Clustering of these objects could be coincidental or temporary

Observational biases

Results of the Outer Solar System Survey (OSSOS) indicate that the perceived clustering may be a result of a combination of observational biases and small-number statistics

- Malmquist biases
- Selection biases
- Geometric biases

3 of the original 6 TNOs that suggested the existence of Planet 9 actually have different inclinations than originally suggested

Further discoveries of TNOs and ETNOS reveal that their orbits are consistent with randomness, and no evidence of clustering is observed

Current Search Efforts

Current operations, legacy data mining, and next-generation observatories closing in on the target.

SUBARU TELESCOPE: OPTICAL SEARCH

- Ongoing Scans: The Subaru Telescope continues its deep, wide-field optical search to detect incredibly faint, slow-moving objects.

- A Revised Orbit: New models have guided the trajectory of this search. As noted by the research team:

> *"The numerical simulations conducted in this study suggest that if Planet Nine exists, its orbit should lie even farther out than previously predicted."* (Subaru Telescope, 2025)

- This adjustment ensures Subaru is looking precisely where the modern physics of the outer solar system dictates.

Figure 11 - Image of the Subaru Telescope.

IRAS / AKARI INFRARED STUDY (2025)

Mining Legacy Data

Researchers are cross-referencing legacy satellite data to spot thermal signatures of a massive body, relying on the motion between observations:

> *"The epochs of these two surveys were separated by 23 years, which is large enough to detect Planet Nine's ~3′/year orbital motion."* (Phan et al., 2025)

A Compelling Candidate

> *"Next, we produced all possible candidate pairs including one IRAS source and one AKARI source… corresponding to the heliocentric distance range of 500 – 700 AU and the mass range of 7 – 17M⊕."* (Phan et al., 2025)

From 13 initial pairs, image inspection yielded one good candidate where the source shifted coordinates. However, "AKARI and IRAS detections are not enough to determine the full orbit of this candidate." (Phan et al., 2025)

THE VERA RUBIN OBSERVATORY

- The Ultimate Dragnet: Having just begun operations, the Vera C. Rubin Observatory represents a paradigm shift with its 10-year survey.

- High Probability: Astrophysicists estimate a 70–80% chance of finding Planet Nine—if it exists within the predicted space.

- Imminent Results: The wait may not be long. As noted by Pedro Bernardinelli, an astronomer at the University of Washington:

> *"Probably within the first year we're going to see if there's something there or not."* (Bernardinelli, 2024)

Figure 12 - Image of the Vera Rubin Observatory.

WHAT IT MEANS

Rethinking the formation, architecture, and extreme boundaries of our cosmic neighborhood.

THE 5-PLANET "NICE" MODEL

An instability-driven dynamical evolution model suggests our early solar system was highly chaotic. A leading theory suggests we initially had an extra ice giant.

> *"Over the last decade, evidence has mounted that the solar system's observed state can be favorably reproduced in the context of an instability-driven dynamical evolution model, such as the 'Nice' model. Here we show that a large array of 5-planet (2 gas giants + 3 ice giants) multi-resonant initial states can lead to an adequate formation of the outer solar system, featuring an ejection of an ice giant during a phase of instability."* (Batygin et al., 2012)

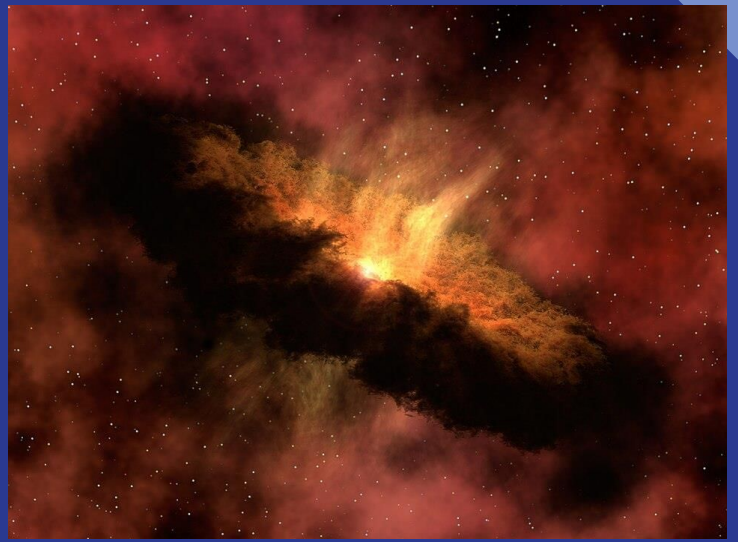


Figure 13 - Disappearing Dust

Planet Nine could be this very "ejected" planetary body, scattered to the distant fringes rather than lost to interstellar space entirely.

STELLAR BIRTH CLUSTER DYNAMICS

Alternatively, interactions in the crowded environment of the Sun's natal stellar cluster could be responsible for Planet Nine's extreme orbit.

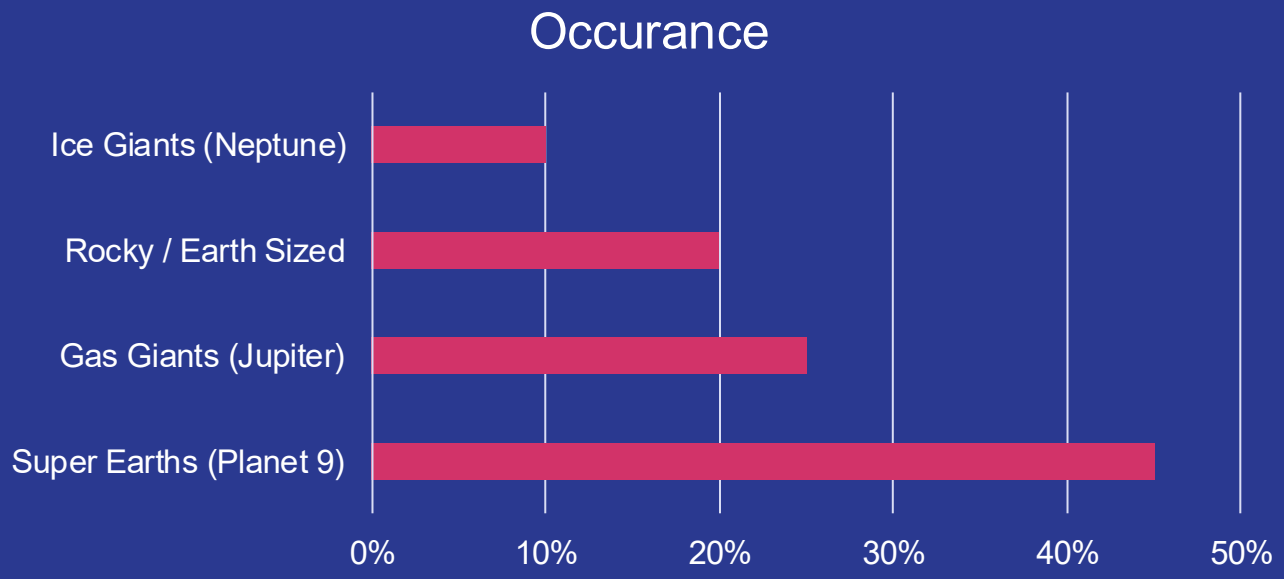
Whether through scattering an indigenous planet outward, or capturing a rogue planet from a passing star, the dense early environment played a role:

> *"We estimate a 5-10% likelihood of creating a very wide-orbit planet if either happened while the Sun was still in its birth cluster, rising to 40% if both were."* (Izidoro et al., 2025)

If captured, Planet Nine would be the first confirmed interstellar exoplanet natively residing within our system.

Figure 14 - Image of young stars.

THE MISSING "NORMAL" PLANET



Discovering Planet Nine (an intermediate Super-Earth) would finally align our solar system's architecture with the most common galactic demographics observed today.

"Our solar system has no example of these intermediate planets, yet they are by far the most common in the Kepler sample." (Fulton et al., 2017)

What do you think?

1. Clustering of distant TNO orbital directions
2. Collective tilt (~20°) of those orbits out of the solar system plane
3. Upside-down orbits (100–120° inclination) at large distances
4. Neptune-crossing objects whose perihelion distribution gives 5-sigma* statistical evidence

1. Clustering of perihelia/inclination may be coincidental, temporary, or nonexistent
2. Collective tilt / retrograde orbits may be caused by self-gravity of Kuiper Belt
3. Gravitational anomaly might not be a planet and might not even be an object
4. New objects discovered do not share perihelion / inclination characteristics, suggesting original objects were result of observational biases

a) Planet 9 must be out there ✅
b) Planet 9 does not exist; the evidence is weak ❌
c) Pluto is my 9th planet