

# how close to L4 and 5 would an exo of $9.6 \times 10^{25}$ and $2 \times$ earth's g/cc have to pass to empty or greatly affect them

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March 28, 2026

To significantly affect or "empty" the

**L4 and L5 Lagrange points** in the Sun-Earth system, an exoplanet with a mass of (roughly 16 times the mass of Earth) would need to pass within approximately **3.78 million kilometers** of the Lagrange point.

Object Characteristics

Based on your parameters, the exoplanet has the following physical properties:

- **Mass:**  
(about 1.7 times the mass of Neptune).
- **Density:**  
(double Earth's average density of ).
- **Calculated Radius:**  
(roughly twice the radius of Earth).

Displacement and Influence

The Lagrange points L4 and L5 are regions of stable equilibrium, but they are held in place by a relatively weak "restoring force" generated by the combined gravity of the Sun and Earth.

- **The Hill Sphere:** To "empty" these points, the exoplanet's gravity must become the dominant force over the local stability of the L-point. This occurs when the L-point falls within the exoplanet's **Hill Sphere** (its zone of gravitational influence).
- **Critical Distance:** For an object of this mass at 1 AU from the Sun, the radius of its Hill Sphere is approximately **3,776,620 km**.

Effect of a Flyby

If the exoplanet passes within this 3.78 million km radius:

1. **Trapped Debris:** Dust, asteroids (Trojans), or satellites currently at L4/L5 would be pulled out of their stable orbits and either collide with the exoplanet, become its temporary moons, or be flung into new, unstable orbits.
2. **Gravitational Perturbation:** Even a pass slightly outside this range (up to ~10 million km) would likely destabilize the "Trojan" orbits, causing the objects to drift away over several orbital cycles.

How do you imagine the **speed of this flyby** affecting the outcome? A slower passage would be far more destructive to the L-point's stability than a "near-miss" at high velocity.

if the exo passed close to the earth that would disrupt the L4 and L5 points?

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Yes,

a close flyby of Earth by a massive exoplanet would absolutely disrupt the **L4 and L5 points**, even if the exoplanet never directly passes through them.

Because L4 and L5 are defined by the gravitational balance between the **Sun** and **Earth**, any major change to Earth's own position or velocity ("state") fundamentally shifts or destroys these stability regions.  $\square$

### 1. Displacement of Earth

If an exoplanet with 16 times Earth's mass ( ) passes close to Earth, its gravity will "tug" on our planet.

- **Orbital Shift:** A change in Earth's semi-major axis of just **0.1%** is enough to destabilize the long-term orbital dynamics of the inner solar system.
- **Lagrange Point Migration:** Since L4 and L5 are always exactly 60° ahead and behind Earth in its orbit, if Earth is pulled into a new, more elliptical or shifted orbit, the L-points must move with it. This sudden "jerk" would likely eject any objects currently "trapped" in those points.  $\square$

### 2. Destruction of the Stability "Bowl"


The stability of L4 and L5 is often compared to a "shallow bowl". European Space Agency

- **Mass Ratio Requirement:** For L4 and L5 to be stable, the more massive body (Sun) must be at least **25 times** heavier than the secondary body (Earth).
- **Temporary Four-Body System:** During the flyby, the system briefly becomes a "four-body problem" (Sun, Earth, Exoplanet, and the L-point object). The exoplanet's massive gravity would "flatten" the stability bowl, allowing objects like Trojan asteroids to simply drift away.

$\square$

### 3. Critical Disruption Distances

While any flyby within Earth's **Hill Sphere** (~1.5 million km) would be catastrophic for Earth itself, a pass much further away would still empty the L-points:

- **Resonance Break:** The exoplanet's gravity would break the 1:1 resonance required to keep objects at L4/L5.
- **Direct "Vacuuming":** If the exoplanet passes closer to an L-point than Earth is (which is roughly 150 million km away), its gravitational influence on that point will momentarily exceed Earth's, effectively "emptying" it. 

Answer

A flyby of Earth by this exoplanet would disrupt the L4 and L5 points by physically shifting Earth's orbit and momentarily overwhelming the delicate gravitational balance that creates these stability zones.

Would you like to explore how such a flyby might specifically affect **Earth's Moon** or our **tides**?