Question 1– Exoplanet Characterization

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Question (a): What is the inclination of GJ 8999 b?

The inclination angle (i) is the angle between a planet's orbital plane and the sky plane as seen by the observer. This angle plays a critical role in determining whether or not the planet transits.

What Does Transit Observation Tell Us?

Since GJ 8999 b transits, it means we observe a decrease in light as the planet passes in front of the star. This event only occurs when the planet's orbit is nearly edge-on to the observer's line of sight.

Conclusion: Since GJ 8999 b exhibits a transit, its inclination angle is approximately 90°.

Question (b): What is the period of this exoplanet?

- The first graph (28-day observation): There are periodic drops in the total flux of star GJ 8999, which indicate the planet's transits.
- The second graph: A zoomed-in view of one of those dips, focusing on a single transit event.

The planet's orbital period is determined by the time interval between successive transits:
In other words, the recurring interval between dips in the star's light represents one full orbit of the planet.

Reading the Period from the Graph: The first graph shows 28 days of data and reveals 6 distinct dips. So, we can reason: There are 6 transits spread across 28 days. Therefore, the time between transits is approximately 5 days.

Estimated Result: The orbital period of exoplanet GJ 8999 b is approximately 5 days.

Question (c): What is the radius of this planet?

The transit depth tells us how much light the planet blocks when it passes in front of is star.

Transit depth = Z = (1 - 0.9975)/(1.0000) x 100% =0.25%

R_p = R_s x sqrt(Z) = 0.2 R x sqrt(0.0025) = 0.2 R x 0.05 = 0.01 R

0.01*109 = 1.09

The radius of planet GJ 8999 b is approximately 0.01 times the radius of the Sun. This means it's about 1.09 times the radius of Earth.

Question (d): What is the semi-amplitude (K) of this planetary signal?

In the graphic, 1 m/s == 1263.5729 mm

v_max == 2787.9066 mm == 2.206 m/s

v_min == -2699.077 mm == -2.136 m/s

semi-amplitude, K = (v_max - v_min)/2 = (2.206 - (-2.136))/2 = 2.171 m/s

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Question (e): What is the mass of this planet?

mp=K/(sin(i)*((2 π G/P((Ms)^2)))*1/3)

K =2.171 m/s
P =5days=432000 s
M=0.2 Mo=0.2*(2*10^30) kg=4*10^28 kg
G=6.674×10−11 m3kg−1s−2
i =90◦,sini = 1

Mp=1.187*10^(25) kg = 1.99 M_earth

Question (f): What is the composition of GJ 8999 b?

R_p = 0.01 R_sun = 0.01 x 6.957 x 10^8 m = 1.092 R_earth
M_p = 1.187x 10^25 kg = 1.99 M_earth

Since the mass is 1.99 Earth masses, it’s represented as **$10^{0.299} M_e$** on a logarithmic axis.

in graph,

0.25Rearth=33pt

so,

0.092Rearth~12pt

1 unit in the x-axis=158pt so,0.299 units~47pt

From the graph, it's clear that the composition of the planet is very near to 33% Rock, 67% Iron.