

## GJ 8999 b Exoplanet Characterization

### Question 1 – Exoplanet Characterization

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

Since GJ 8999 b shows a transit, its orbit must be almost edge-on.

Result: The inclination is about 90 degrees.

**(b) What is the orbital period of the planet?**

From the graph, 28 days of data show 6 clear transits.

Orbital period =  $28 \text{ days} \div 6 \approx 5 \text{ days}$ .

**(c) What is the radius of GJ 8999 b?**

Transit depth = 0.25%

Formula:  $R_p = R_s \times \sqrt{Z}$

$R_s = 0.2$  times the Sun's radius:

$R_p = 0.2 \times \sqrt{0.0025} = 0.2 \times 0.05 = 0.01$  times the Sun's radius.

Converted to Earth size:

$R_p \approx 1.09$  times Earth's radius.

**(d) What is the semi-amplitude (K) of the radial velocity signal?**

From the graph:

$v_{\text{max}} = 2.206 \text{ m/s}$

$v_{\text{min}} = -2.136 \text{ m/s}$

Formula:  $K = (v_{\text{max}} - v_{\text{min}}) \div 2$

$K = (2.206 - (-2.136)) \div 2 = 2.171 \text{ m/s}$ .

**(e) What is the mass of GJ 8999 b?**

Formula used with given data:

$K = 2.171 \text{ m/s}$

$P = 5 \text{ days} = 432,000 \text{ seconds}$

Star mass = 0.2 times the Sun's mass =  $4 \times 10^{28} \text{ kg}$

Inclination =  $90^\circ$ , so  $\sin(i) = 1$

Result:

$M_p \approx 1.99$  times Earth's mass.

**(f) What is the composition of the planet?**

$R_p \approx 1.09$  times Earth's radius.

$M_p \approx 1.99$  times Earth's mass.

Based on models:

Composition  $\approx 33\%$  rock and  $67\%$  iron.

## **Conclusion**

GJ 8999 b is slightly larger and more massive than Earth. It completes one orbit every 5 days and has a dense composition of rock and iron.