

# Project 1

# Detect Earth-like Exoplanets

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# Detection Methods

Direct Imaging:

$$f = \frac{\pi R_p^2}{4\pi a^2} A \Rightarrow$$

$$a = \sqrt{\frac{0.32\pi R_p^2}{4\pi f}}$$
$$R_p = \sqrt{\frac{4\pi a^2 f}{0.32\pi}}$$

A = estimated albedo, which we calculate to be around 0.32 for planets in our solar system. For JWST,  $f=10^{-4}$

Radial Velocity:

$$K = \frac{m_p}{m_*} \sqrt{\frac{Gm_*}{a}} \sin i \Rightarrow m_p = K \cdot m_* \cdot \sqrt{\frac{a}{Gm_*}}$$

G = gravitational constant,  $\sin(i)$  = inclination

# Detection Methods

Transit:

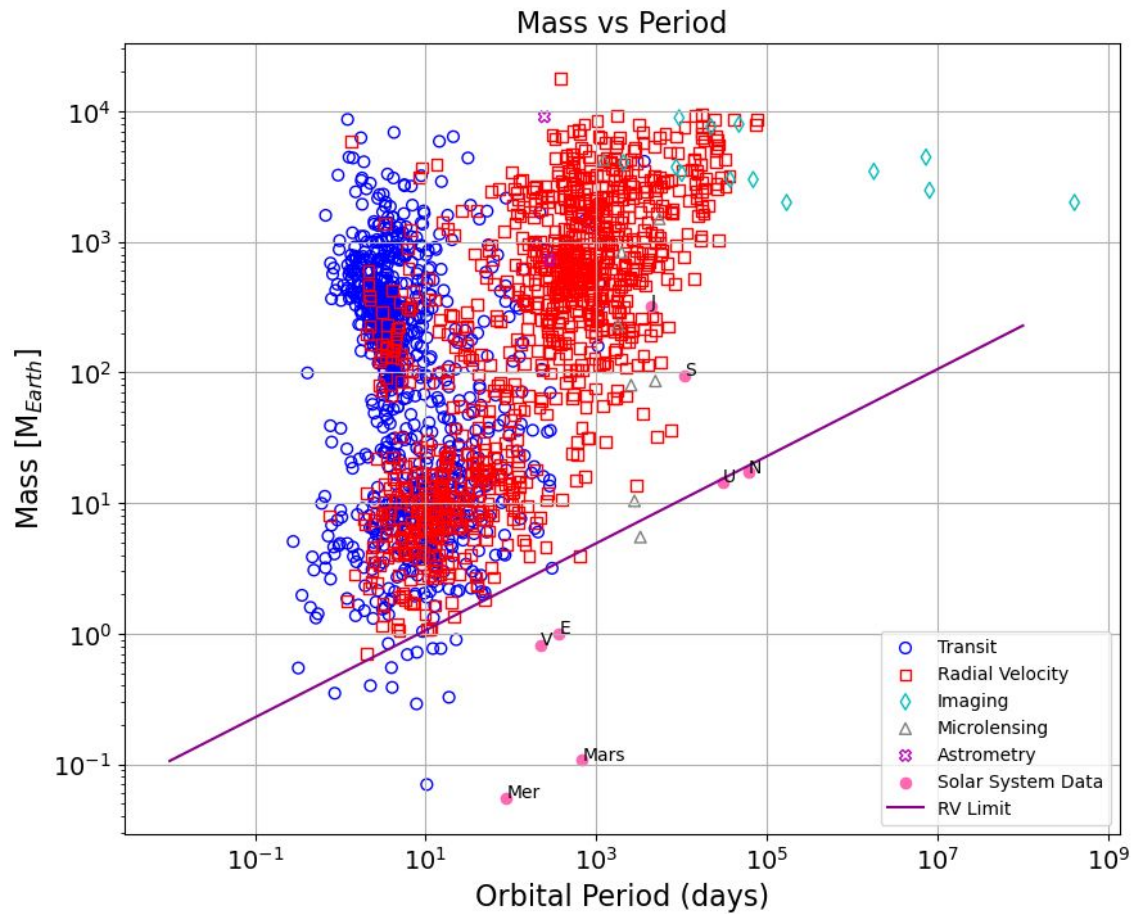
$$P = \frac{R_* + R_p}{a} \quad f = \left( \frac{R_p}{R_*} \right)^2$$

Astrometry:

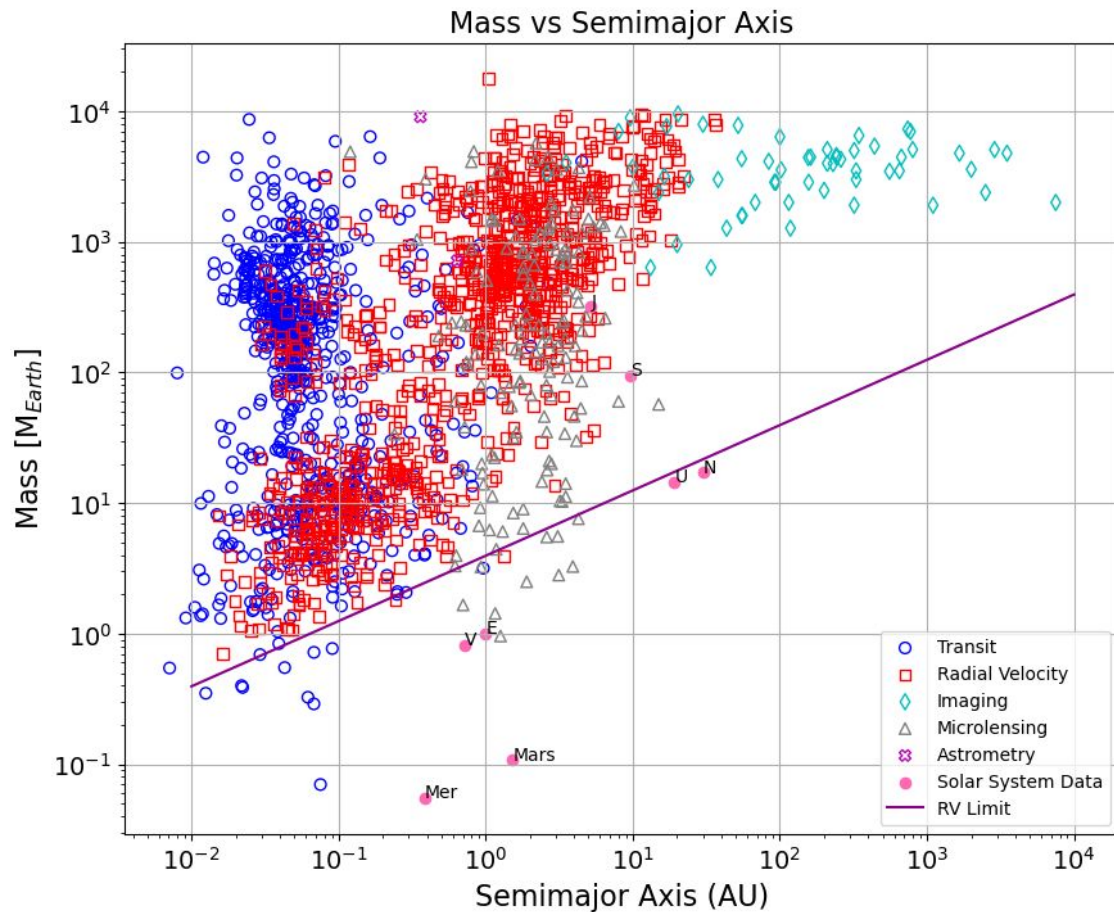
$$\theta = \left( \frac{M_P}{M_*} \right) \frac{a}{d} \quad \Rightarrow \quad \theta = 3\mu as * \left( \frac{M_p}{M_{\oplus}} \right) \left( \frac{M_*}{M_{\odot}} \right)^{-\frac{2}{3}} \left( \frac{P}{yr} \right)^{\frac{2}{3}} \left( \frac{d}{pc} \right)^{-1}$$

Microlensing

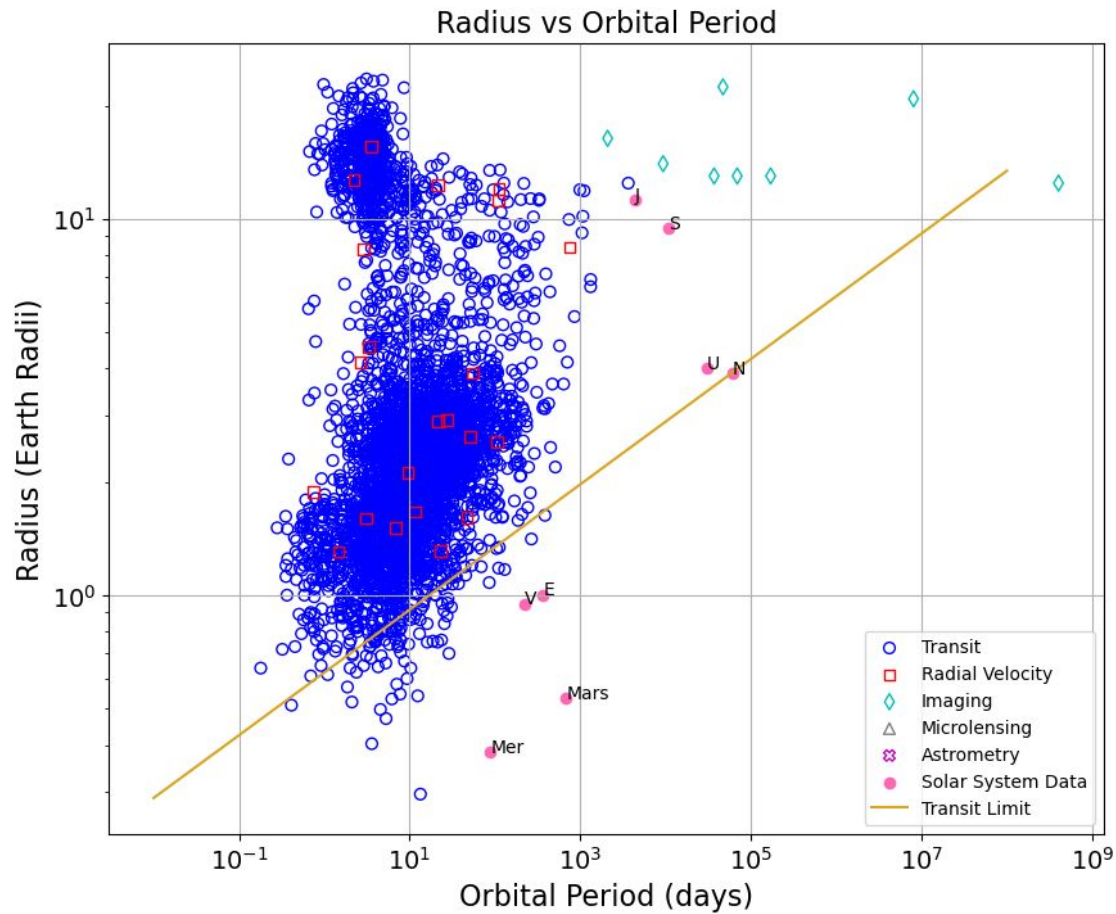
# Mass vs period



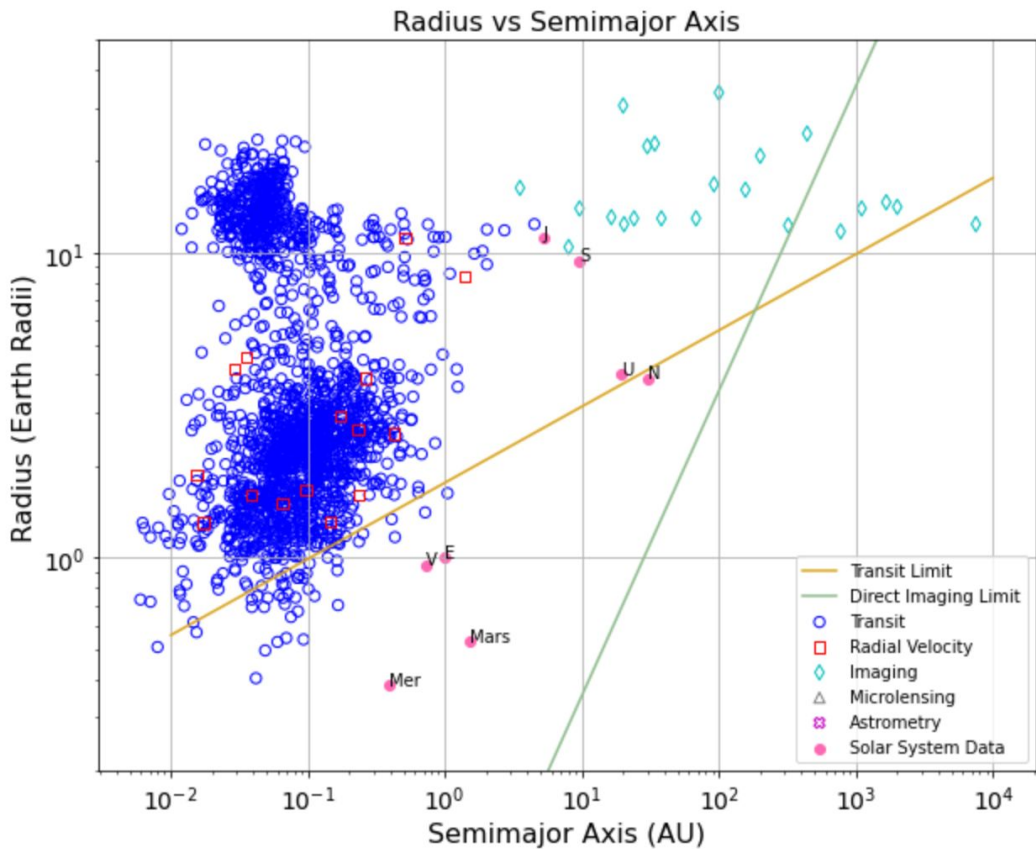
# Mass vs semi-major axis



# Radius vs period



# Radius vs semi-major axis



## Calculation - Detecting another Earth

- Direct Imaging:  $1.5 \times 10^{-10}$  vs  $10^{-4}$
- Radial Velocity: 0.09m/s vs 0.5 m/s
- Transit Method:  $f=0.0084\%$  vs  $f=0.0134\%$



# Conclusion

The solar system seems unique on the plots.

We currently do not have the technical possibilities to find an Earth-like exoplanet.