Project 1
Detect Earth-like Exoplanets

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Detection Methods

Direct Imaging:

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

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

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

Radial Velocity:

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

G = gravitational constant, sin(i) = inclination

Detection Methods

Transit:

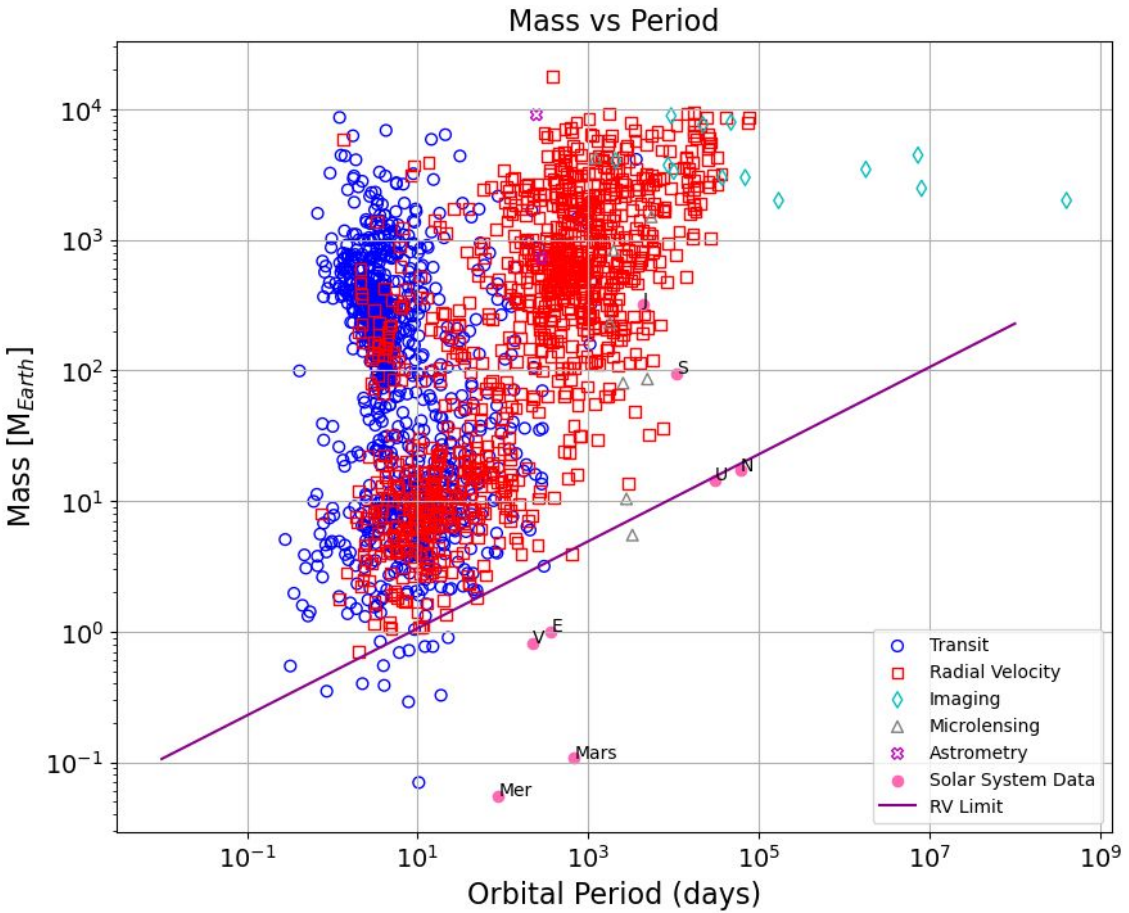
$$P = \frac{R_* + R_p}{a} \qquad f = \left(\frac{R_p}{R_*}\right)^2$$

Astrometry:

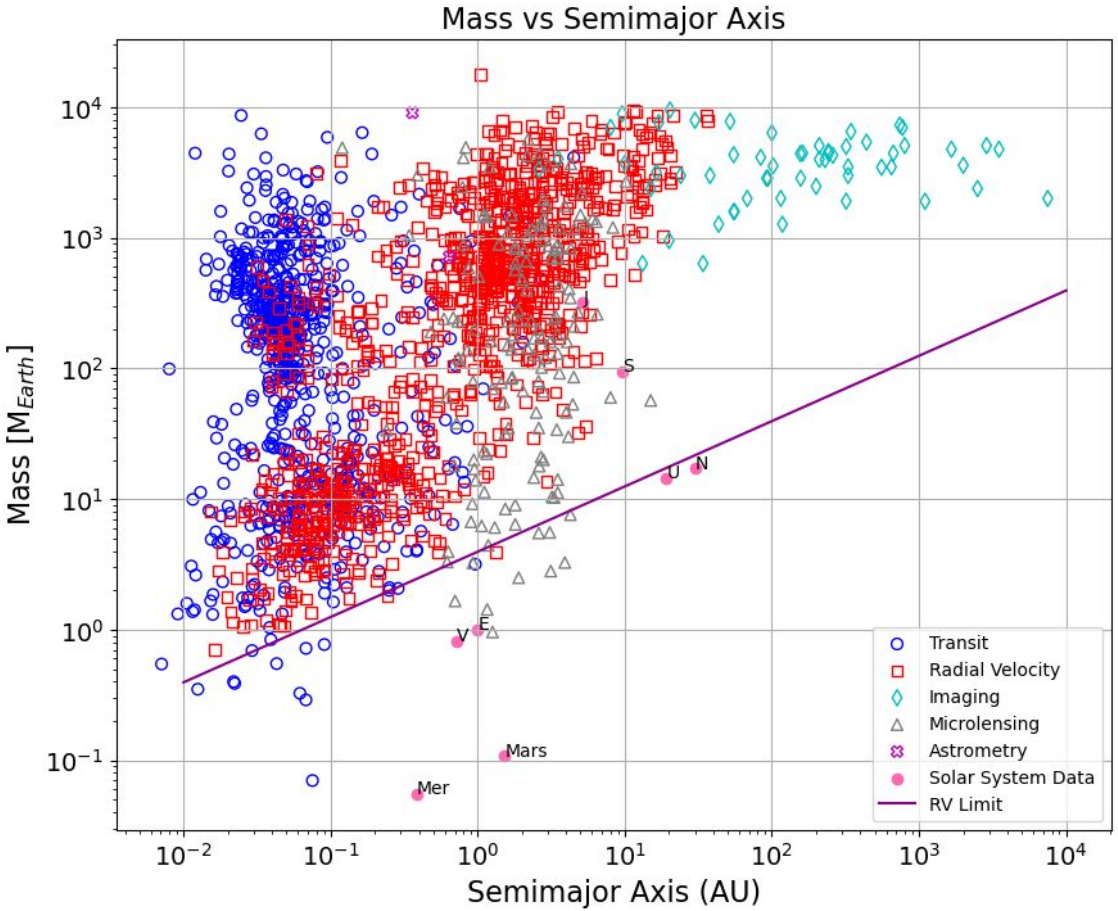
$$\theta = \left(\frac{M_P}{M_*}\right)\frac{a}{d} \quad \Longrightarrow \quad \theta = 3\mu as * \left(\frac{M_p}{M_\oplus}\right)\left(\frac{M_*}{M_\odot}\right)^{\frac{-2}{3}}\left(\frac{P}{yr}\right)^{\frac{2}{3}}\left(\frac{d}{pc}\right)^{-1}$$

Microlensing

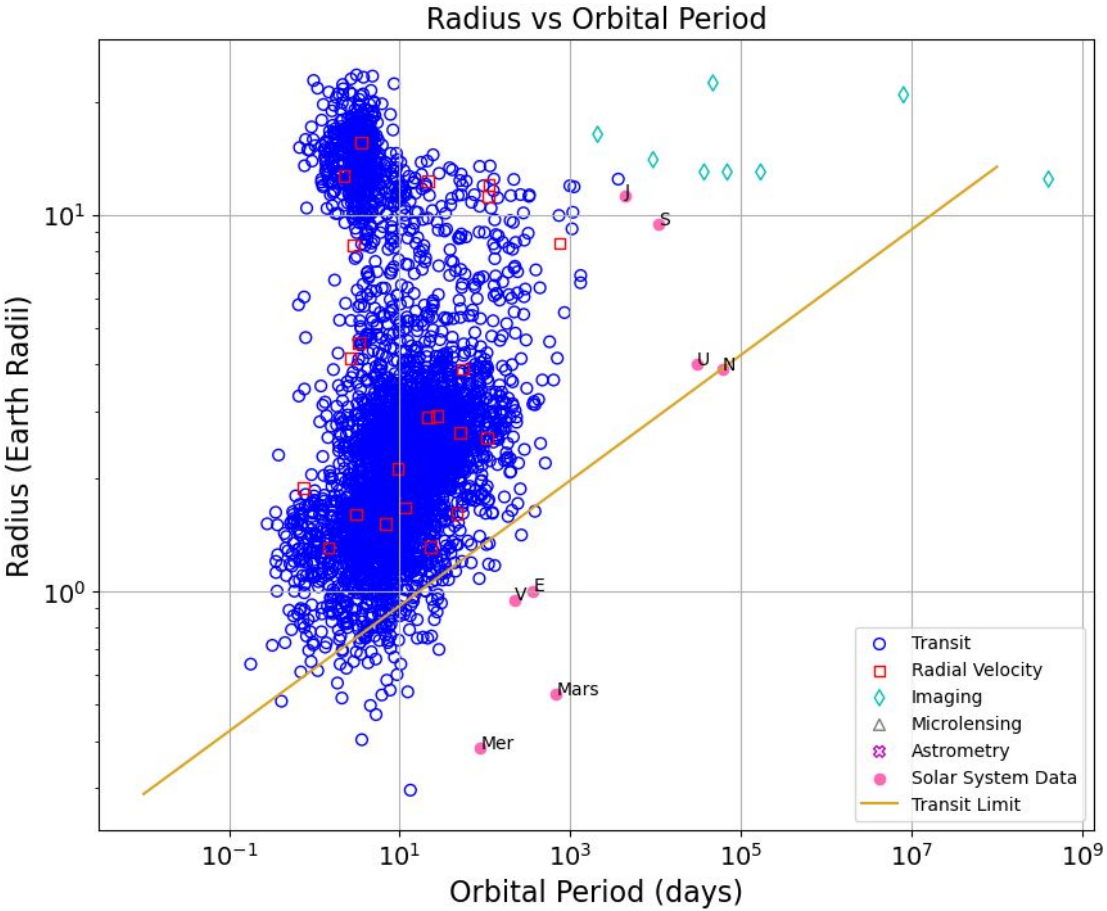
Mass vs period



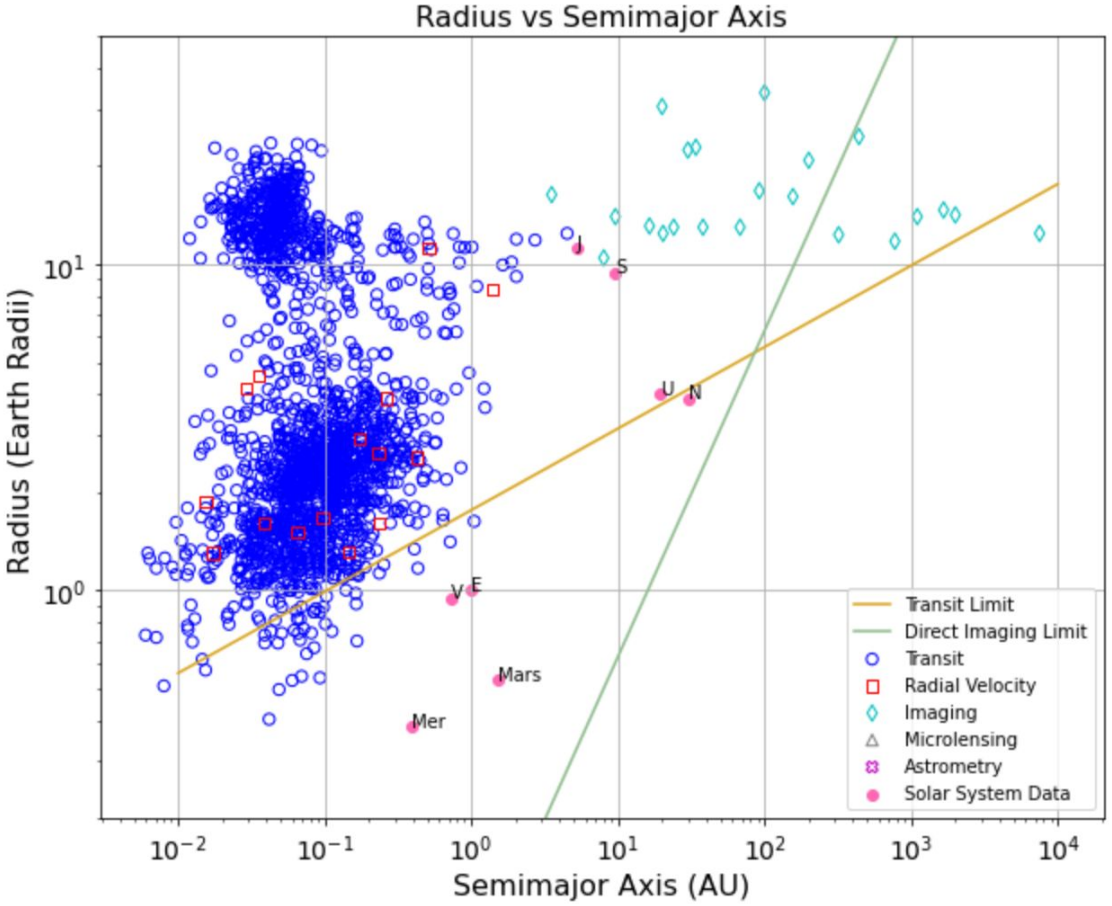
Mass vs semi-major axis



Radius vs period



Radius vs semi-major axis



Calculation - Detecting another Earth

- Direct Imaging: 10^{-5} vs $2*10^{-4}$
- Radial Velocity: 0.09m/s vs 0.5 m/s
- Transit Method: f=0.0084% vs f=0.0134%

Conclusion

Solar system seems unique on the plots.

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