Exoplanet Detection Project

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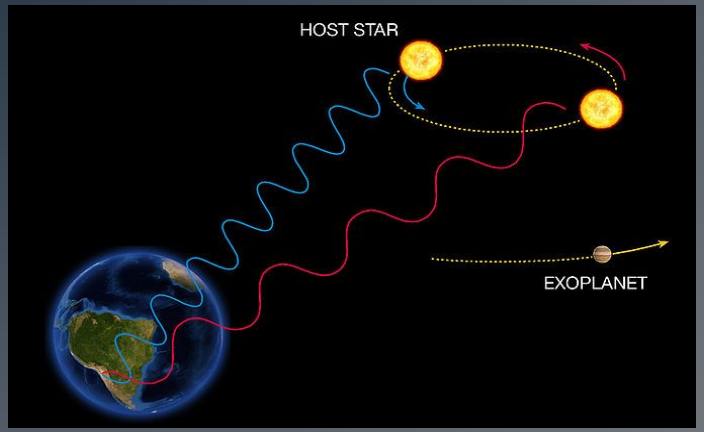
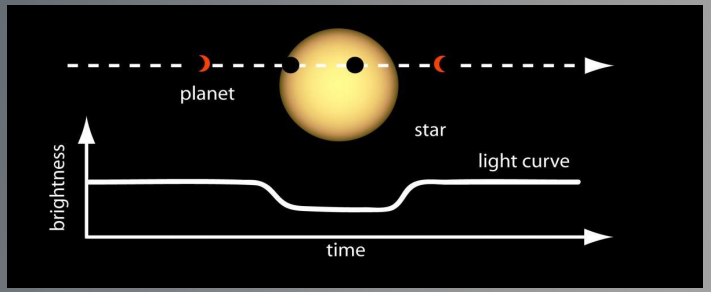
Motivation

Grow understanding of 3 different **exoplanet detection methods**:

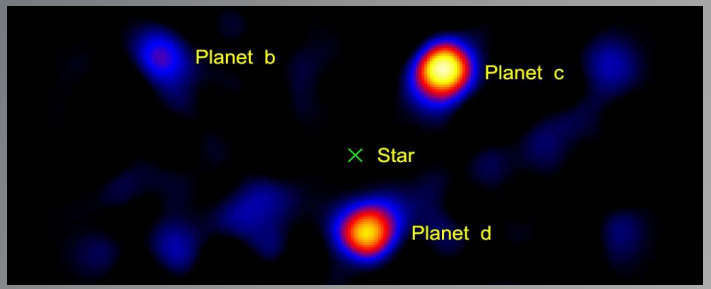
Radial Velocity



Transits



Direct Imaging



Methods

Kepler's Third Law: $a^2 \sim T^3$

Mass-Radius Relation:

Terrestrial: $R \sim M^{0.28}$

Neptunian: $R \sim M^{0.59}$

Jovian: $R \sim M^{0.04}$

$$\left(\frac{R_P}{R_\oplus}\right)^2 = 3\sqrt{\frac{P}{T}}$$

$$\Downarrow$$

$$R_P = R_\oplus \left\{3\left(\frac{P}{T}\right)^{1/2}\right\}^{1/2}$$

$$K = \frac{M_P}{M_\star}\sqrt{\frac{GM_\star}{a}}\sin i$$

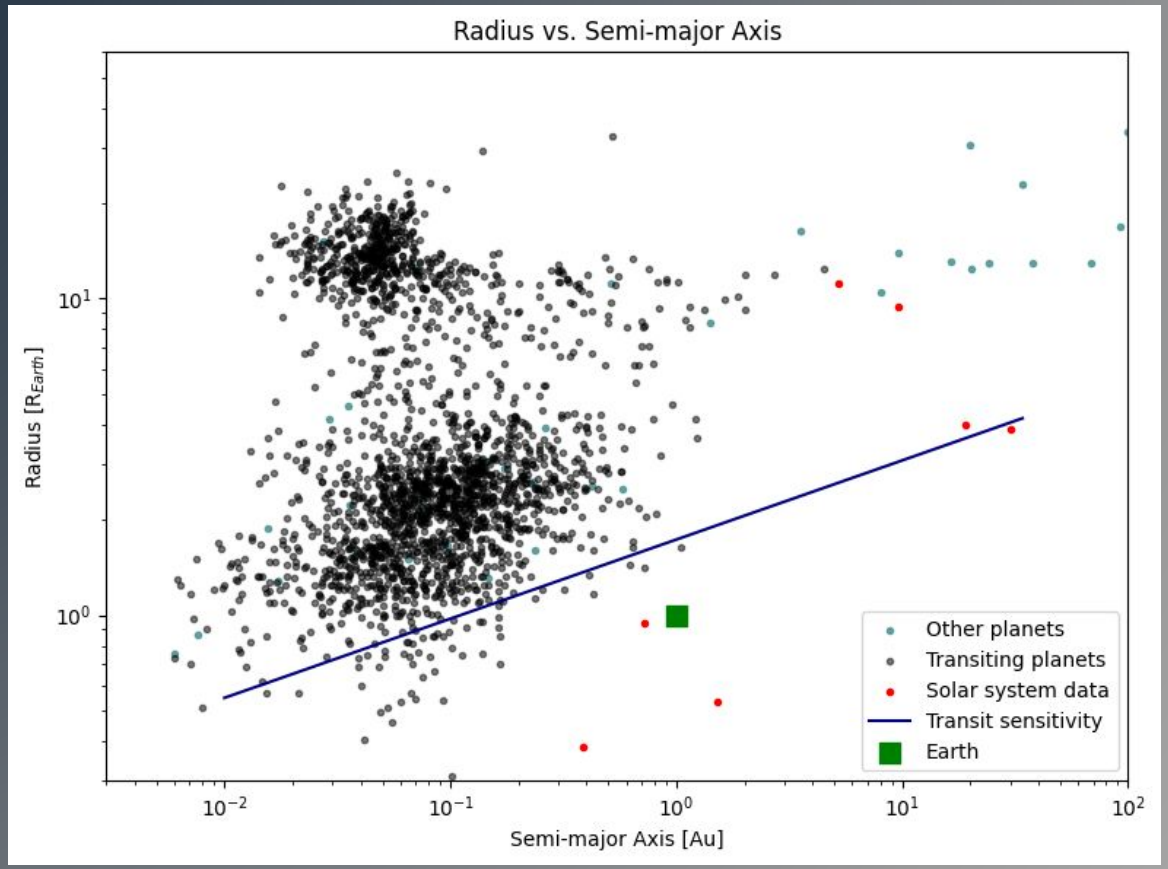
$$\Downarrow$$

$$M_P = KM_\star\sqrt{\frac{a}{GM_\star}}$$

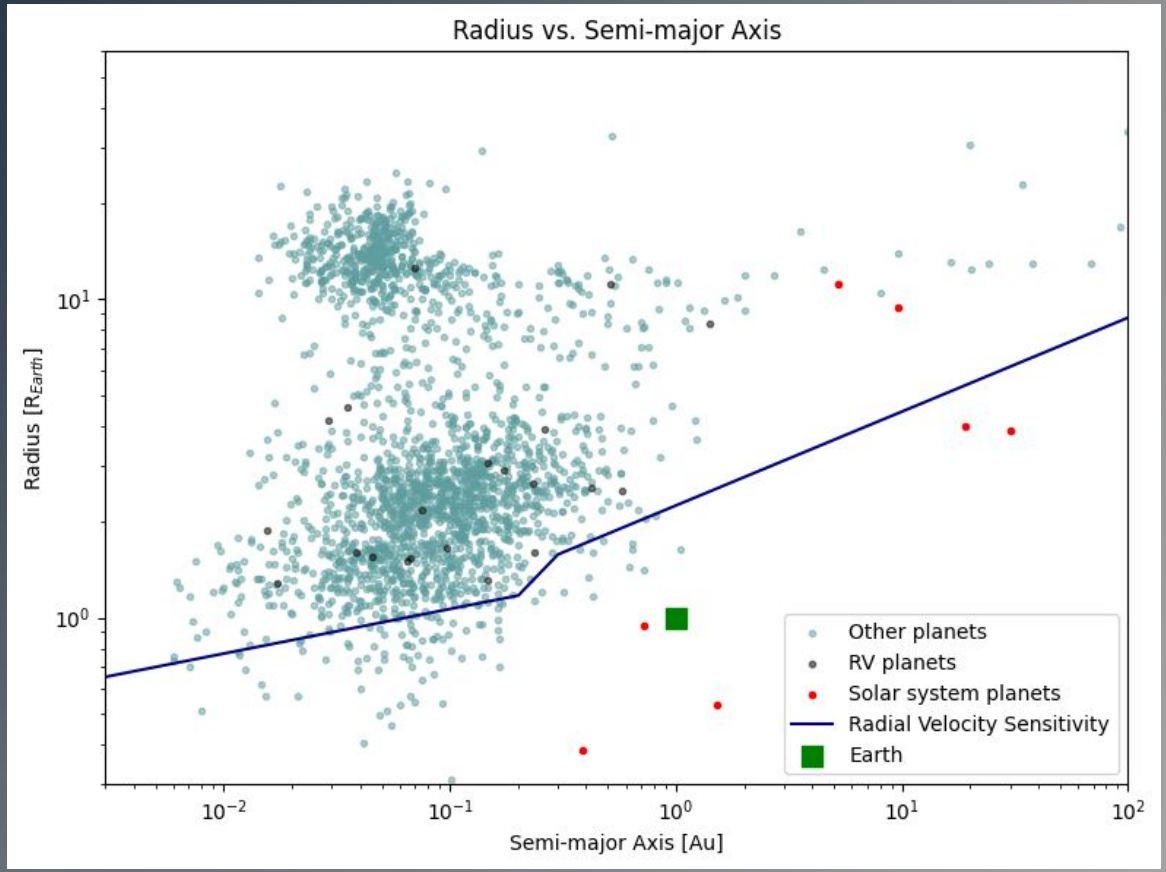
$$C = \frac{f_{planet}}{f_\star} = \left(\frac{R_{planet}}{R_\star}\right)^2 \frac{e^{\frac{hc}{\lambda k T_{planet}}} - 1}{e^{\frac{hc}{\lambda k T_\star}} - 1} \Rightarrow R_{planet} = R_\star \sqrt{C_{lim} \frac{e^{\frac{hc}{\lambda k T_\star}} - 1}{e^{\frac{hc}{\lambda k T_{planet}}} - 1}}$$

$$a = D \times \theta$$

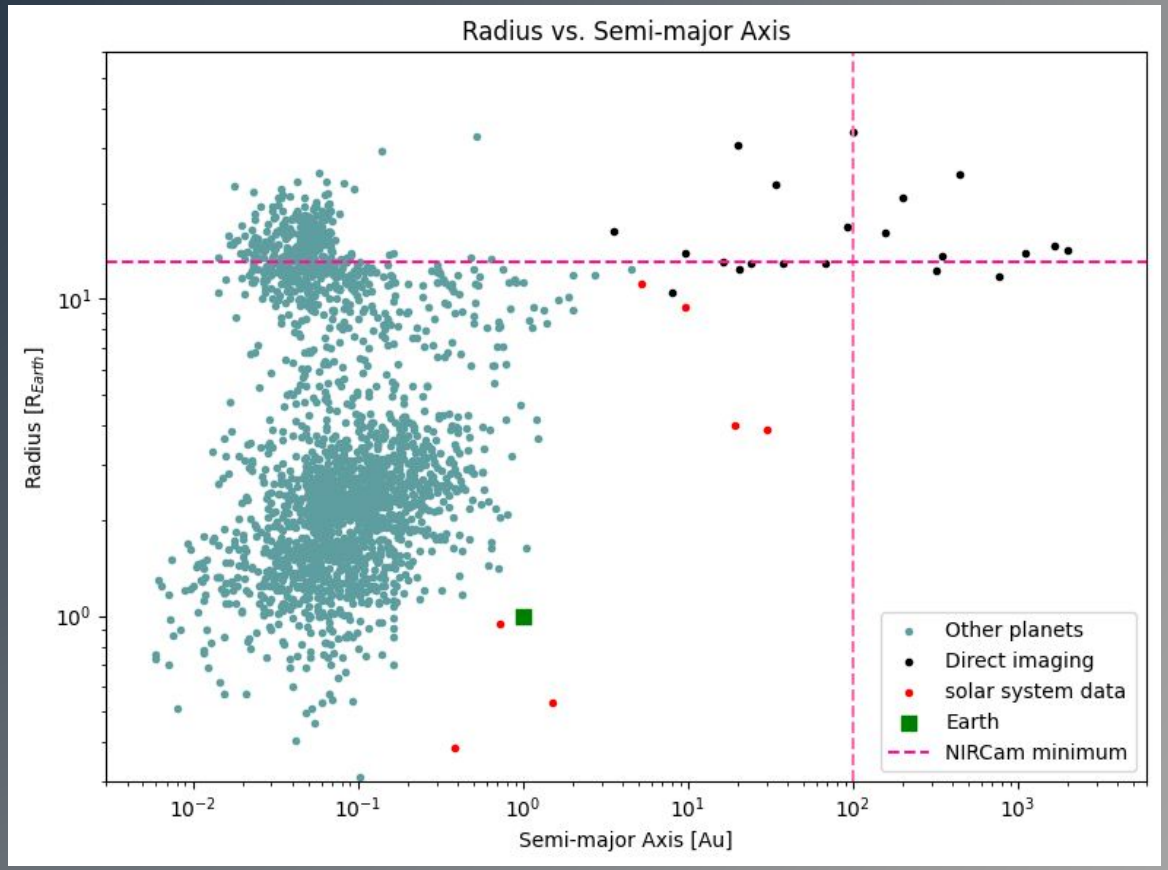
Transit


Radius vs. Semi-major Axis
Radius [R_{Earth}]
10^1
10^0
10^{-2}
10^{-1}
10^0
10^1
10^2
Semi-major Axis [Au]
Other planets
Transiting planets
Solar system data
Transit sensitivity
Earth

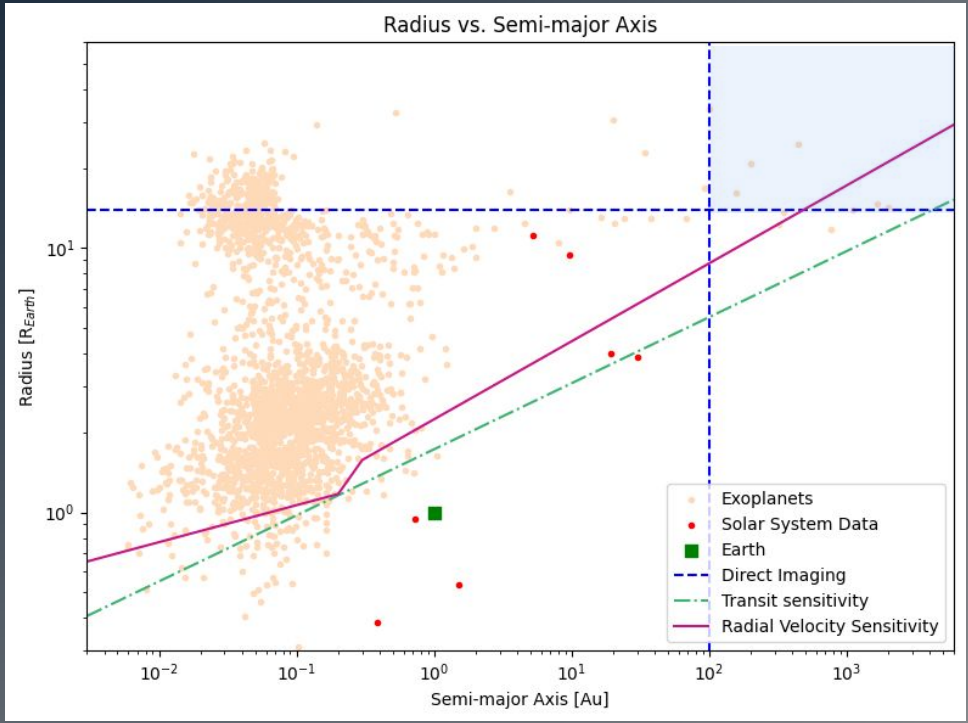
Radial Velocity



Direct Imaging



Conclusions



1. Gas giants best for RV and Transits
2. Earth-like exoplanets are undetectable by all three methods
3. Technological improvements necessary to better detect habitable planets
4. Direct imaging pretty limited capacity currently
5. Transits method is responsible for ~**74%** of exoplanet detection

Questions?

References

Photos on Motivation slides:

- We're One Step Closer To Finding The Holy Grail Of Exoplanets
- What is Radial Velocity - Speed Towards or Away From A Viewer
- What is the Direct Imaging Method? - Universe Today