Exoplanet Detection Project

Group 9
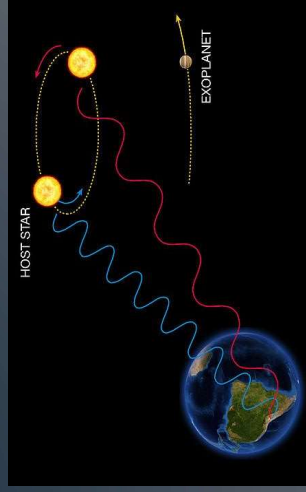
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01-30-25
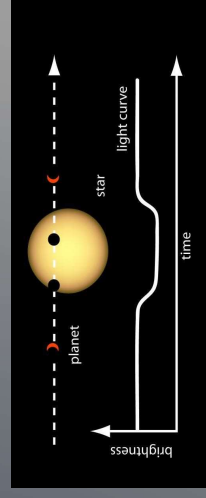

Motivation

Grow understanding of 3 different exoplanet detection methods:

Transits

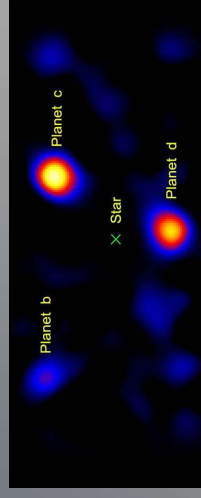### Direct Imaging

Planet b

Planet c

Planet d

× Star

Radial Velocity

HOST STAR

EXOPLANET

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: $R \sim M^{0.04}$

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

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

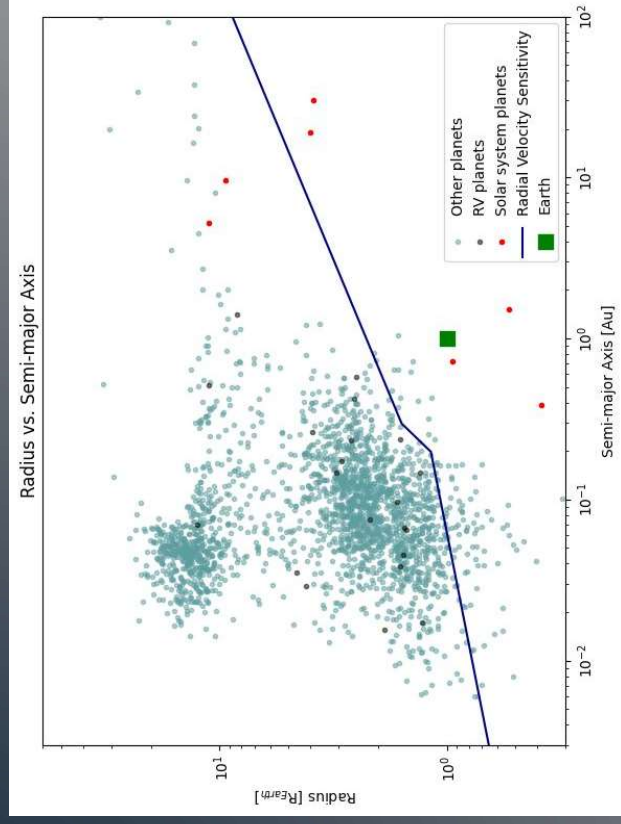$$C = \frac{f_{planet}}{f_\star} = \left(\frac{R_{planet}}{R_\star}\right)2\,\frac{e^{\frac{hc}{\lambda k T_{planet}}} - 1}{e^{\frac{hc}{\lambda k T_\star}} - 1} \implies R_{planet} = R_\star\sqrt{C_{lim}\frac{e^{\frac{hc}{\lambda k T_\star}} - 1}{e^{\frac{hc}{\lambda k T_{planet}}} - 1}}$$
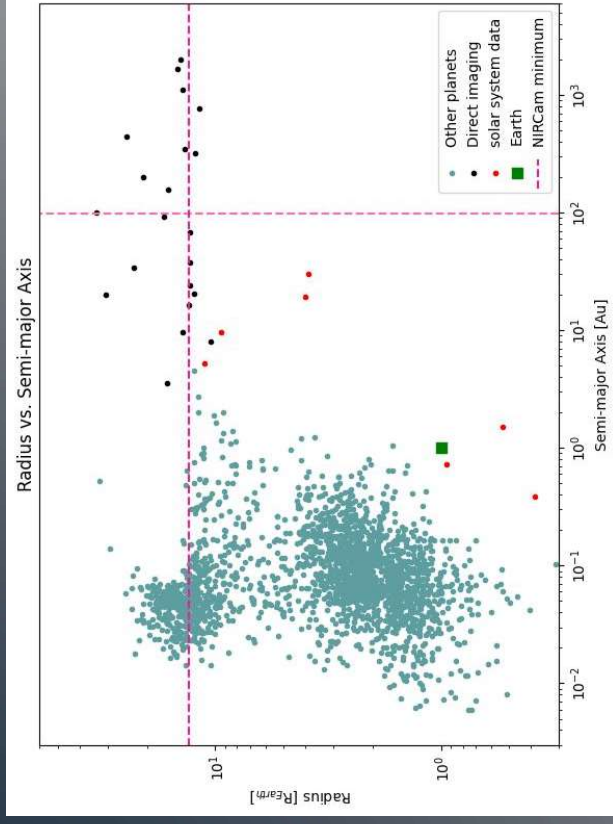
$$a = D \times \theta$$

Transit
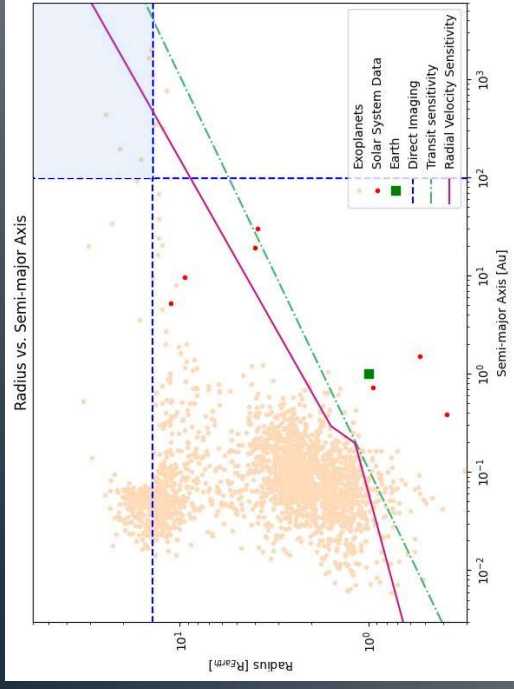

Radius vs. Semi-major Axis
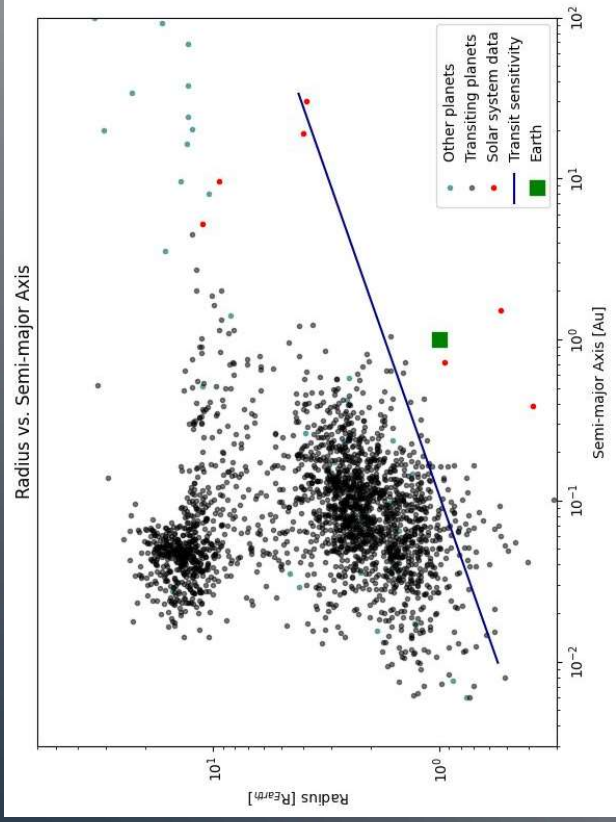
Radial Velocity

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 <u>habitable planets</u>
4. Direct imaging pretty limited capacity currently
5. Transits method is responsible for **~74%** of exoplanet detection

Radius vs. Semi-major Axis

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](#)