SURF SMART:
# Quantifying the Effect of Undetected Planets on RV Mass Measurements

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Exoplanet Background

- Exoplanet: Planet outside of our Solar System
- Multi-planet System: Stars with at least 2 confirmed planets
- Radial Velocity Method: Measuring velocity of star toward/away from us
- Doppler Wobble: star movement results in Doppler shift
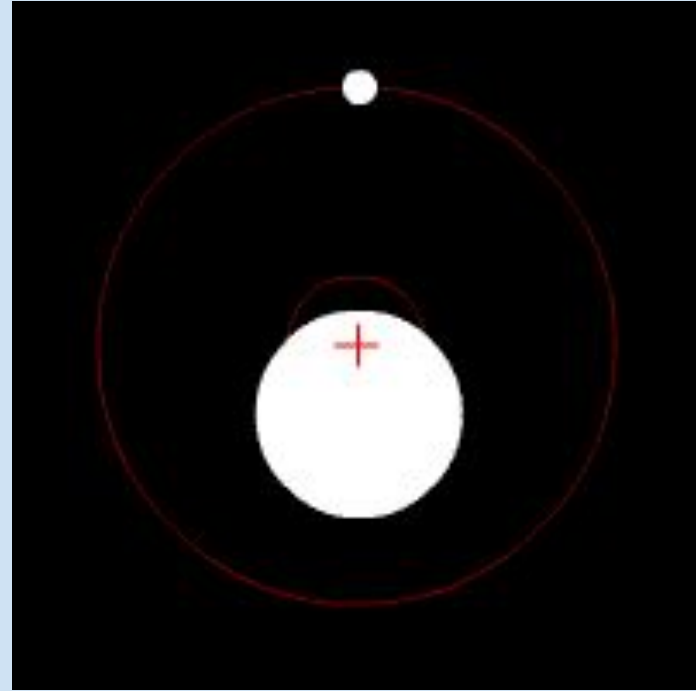
Project Background

- We fit radial velocity data to find min. mass value
- Fixed parameters: # of planets, period
- Varied parameters: eccentricity, minimum mass

$P_f = 93.80$ days
$K_f = 4.5 \pm 0.65$ m s^{-1}
$e_f = 0.07 \pm 0.076$
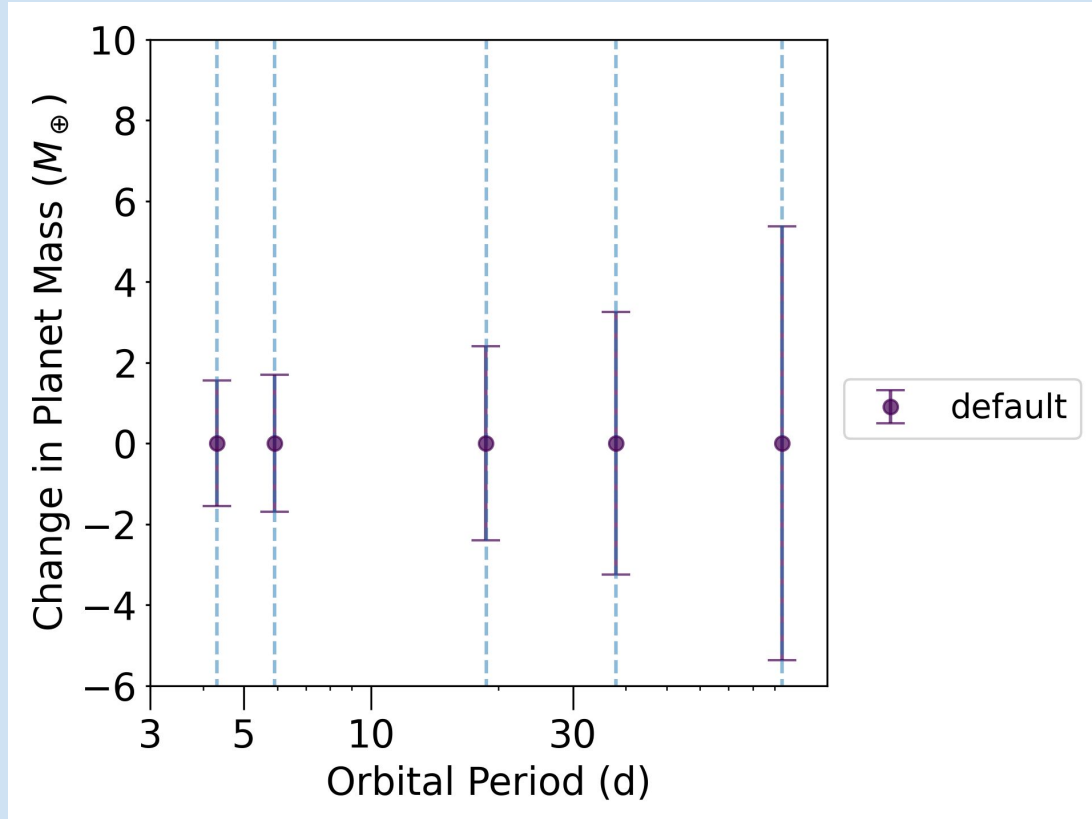$M_f \sin i = 28.5 \pm 4.9$ M$_\oplus$
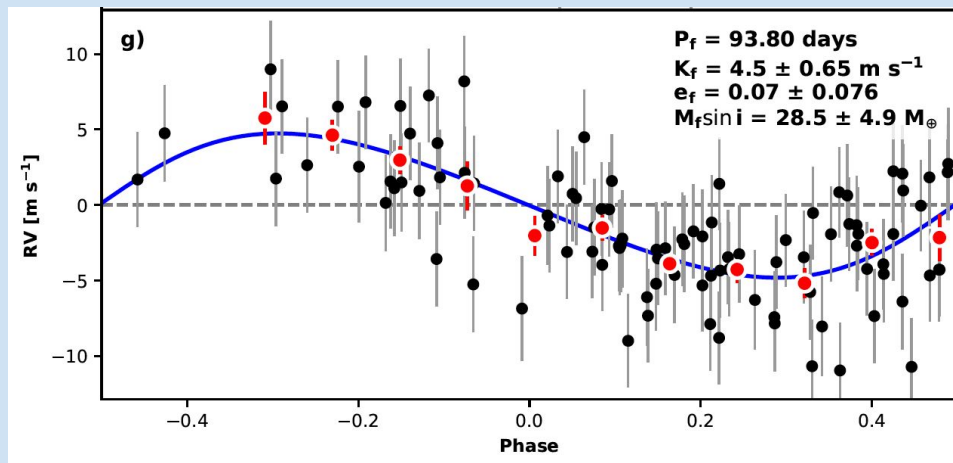
Analysis Steps

- How robust are the calculated min. mass values?
- Perform fit with original # of planets to find masses
- Add additional planet between two planets and repeat fit
- E.g., TOI–1246

add bc   add cd   add de   add ef
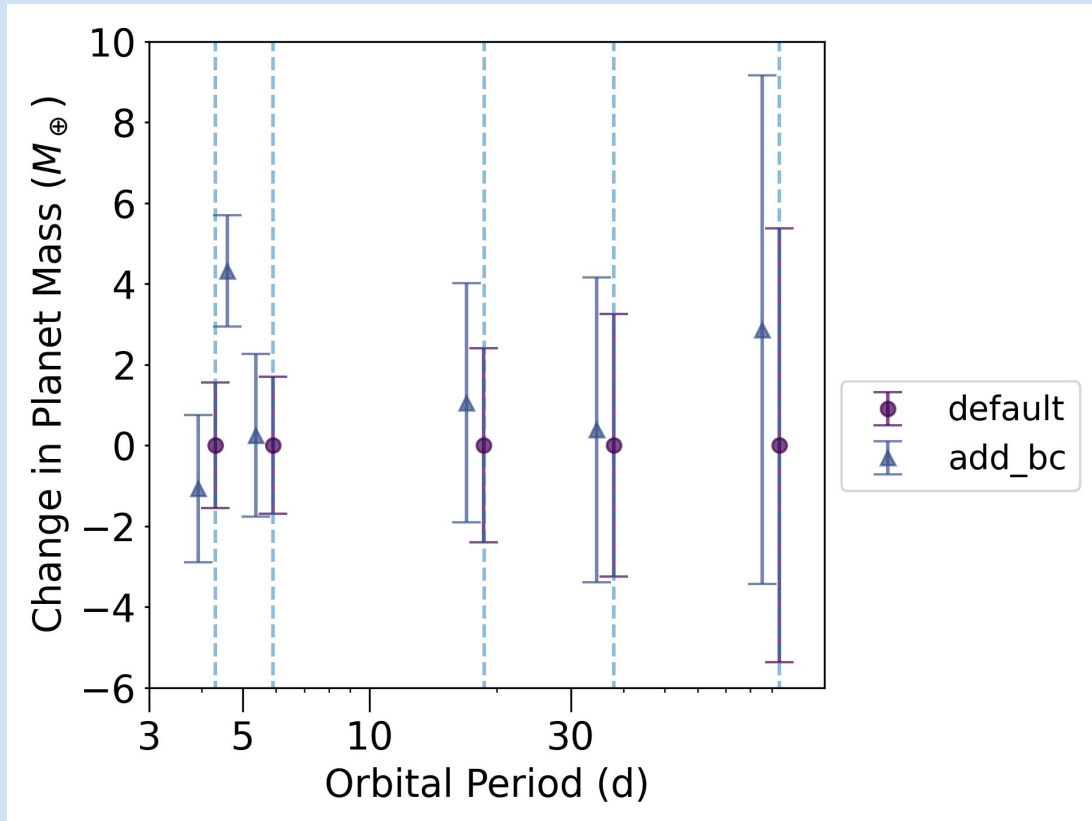
b   **c**   **d**   **e**   **f**
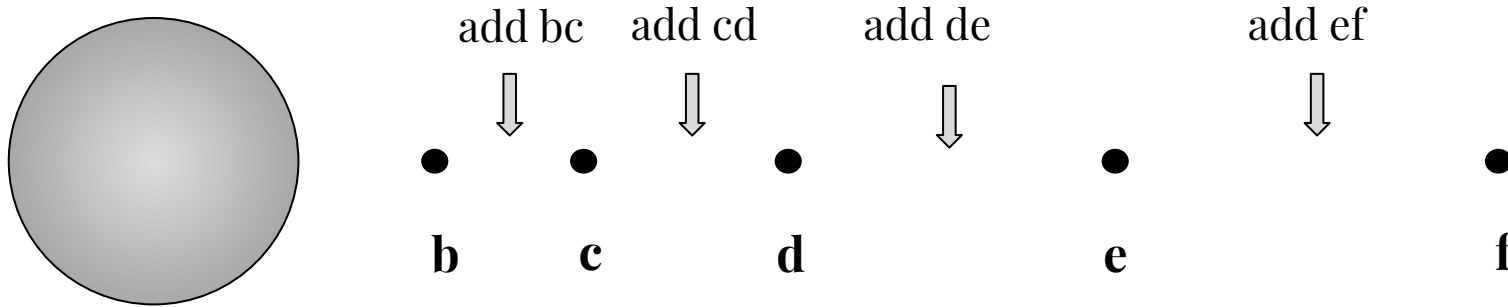
We end up with 5 sets of data: default, add bc, add cd, add de, add ef
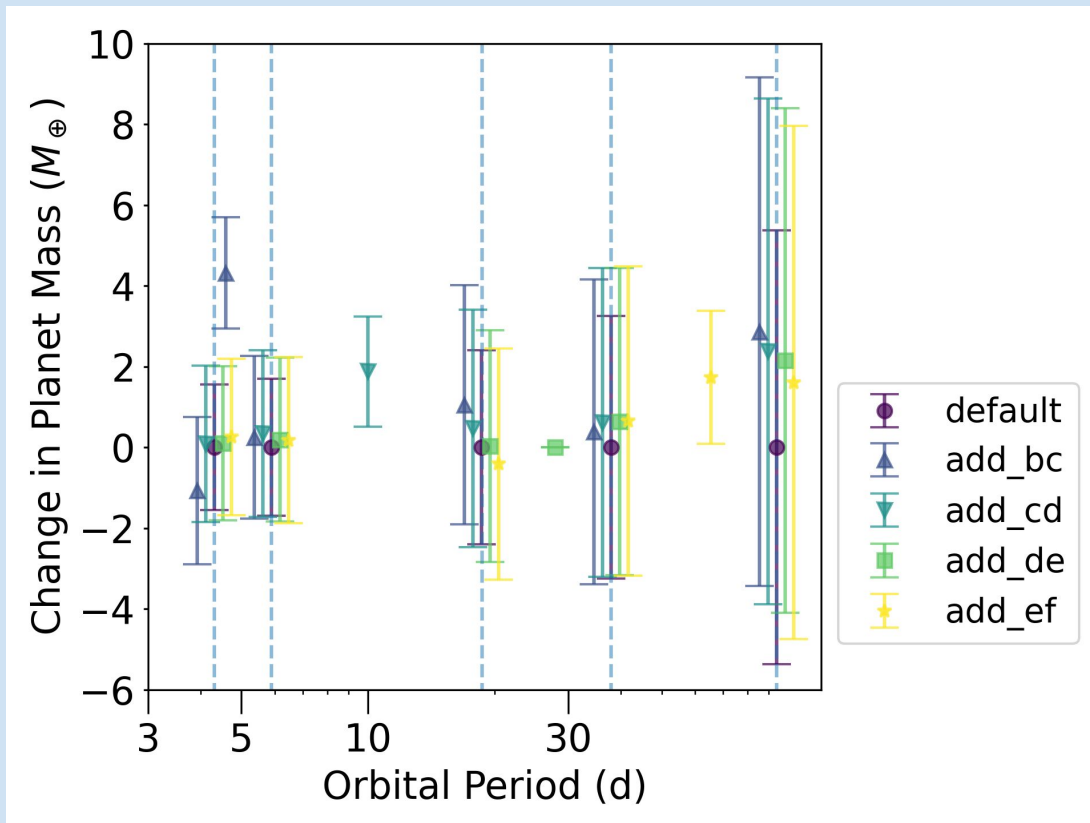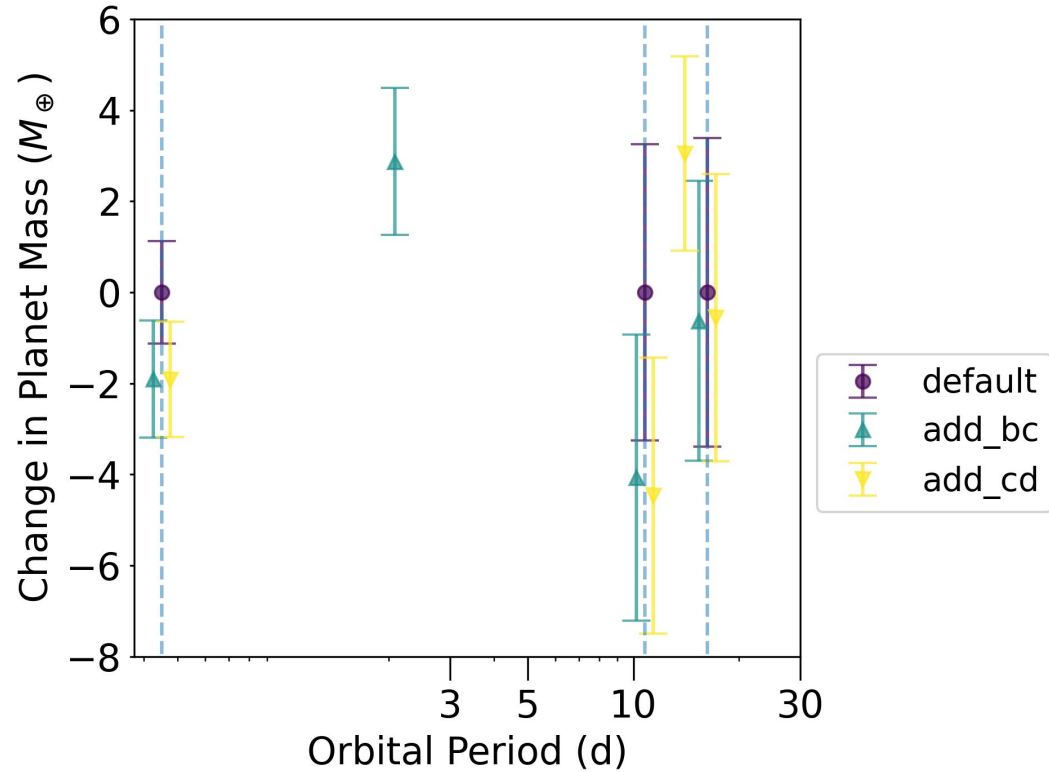
Example Plot

Example Plot

Example Plot

Example Plot (pt. 2)

Summer Overview

- Studying background+literature

- Building on code to add functionality

- Effectively visualizing information

- Future steps:

    - What additional parameters can we account for?

    - Are the plots communicating the necessary information?

    - Can we see patterns in multiple systems?

References

Lovis, Christophe, and Debra Fischer. "Radial velocity techniques for exoplanets." *Exoplanets* (2010): 27-53.

Turtelboom, Emma V., et al. "The TESS-Keck Survey. XI. Mass Measurements for Four Transiting Sub-Neptunes Orbiting K Dwarf TOI–1246." *The Astronomical Journal* 163.6 (2022): 293.

Weiss, Lauren M., et al. "The TESS-Keck Survey. II. An Ultra-short-period Rocky Planet and Its Siblings Transiting the Galactic Thick-disk Star TOI-561." *The Astronomical Journal* 161.2 (2021): 56.