Detecting Circumbinary Planets Using Radial Velocity Methods

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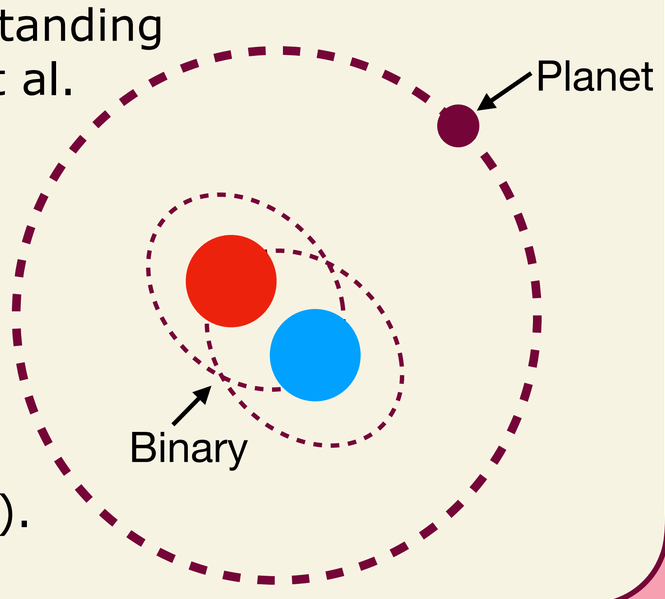
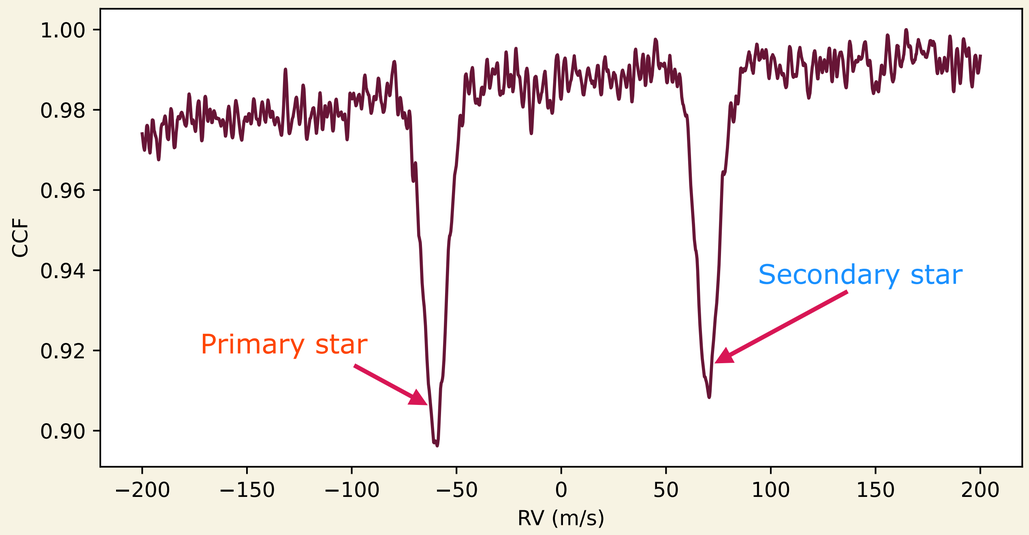
Introduction

- Circumbinary planets are exoplanets that orbit both stars of a binary.
- Out of the 5926 exoplanets discovered (NASA Exoplanet Archive) **only 39 are confirmed circumbinary planets.**
- Only **4 circumbinary planets have been confirmed using radial velocity methods** (Triaud et al. 2022; Standing et al.2023; Siaram et al. 2024; Baycroft et al. 2025).
- **KIC 5095269** has a circumbinary planet found from eclipse timing variations (Goldberg et al. 2023).



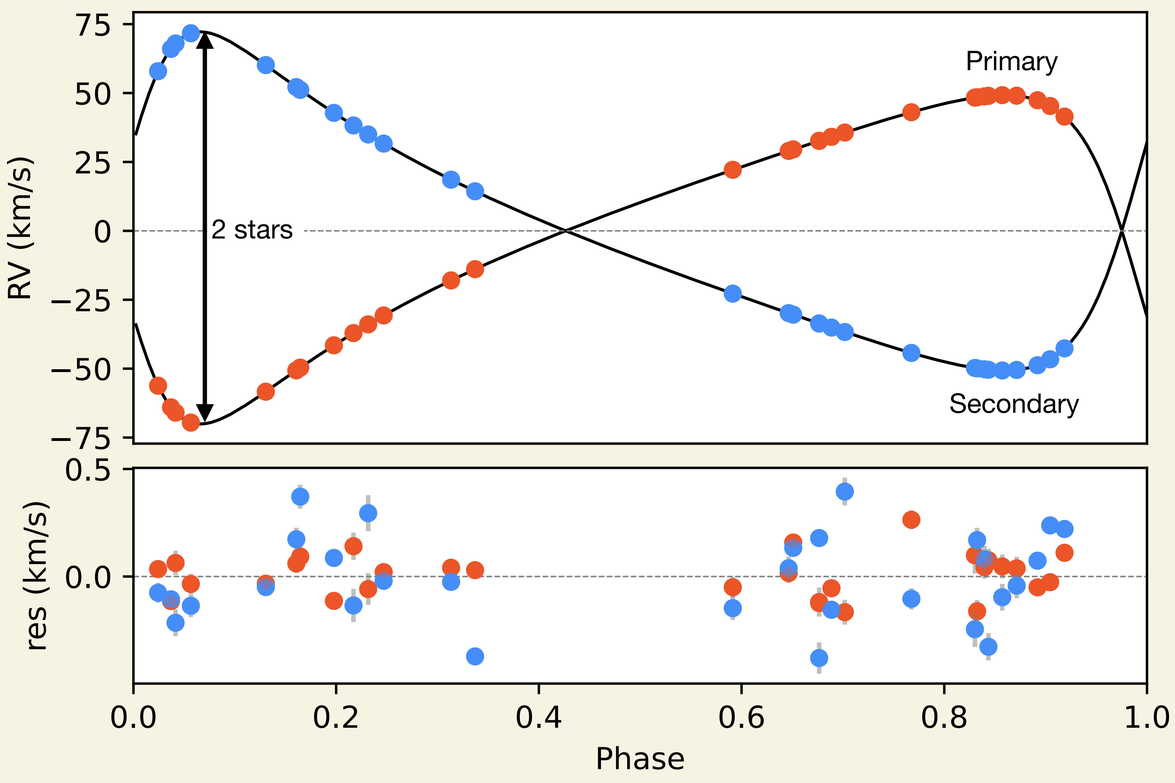
Method

- 30 epochs of data from SOPHIE spectrograph, France.
- Use *DOLBY-CCF* (Sairam et al. 2024) to derive precise RVs from the CCFs of **double-lined binaries**
- Use the nested sampler *KIMA* (Faria et al. 2018) to fit the RVs and search for planets.



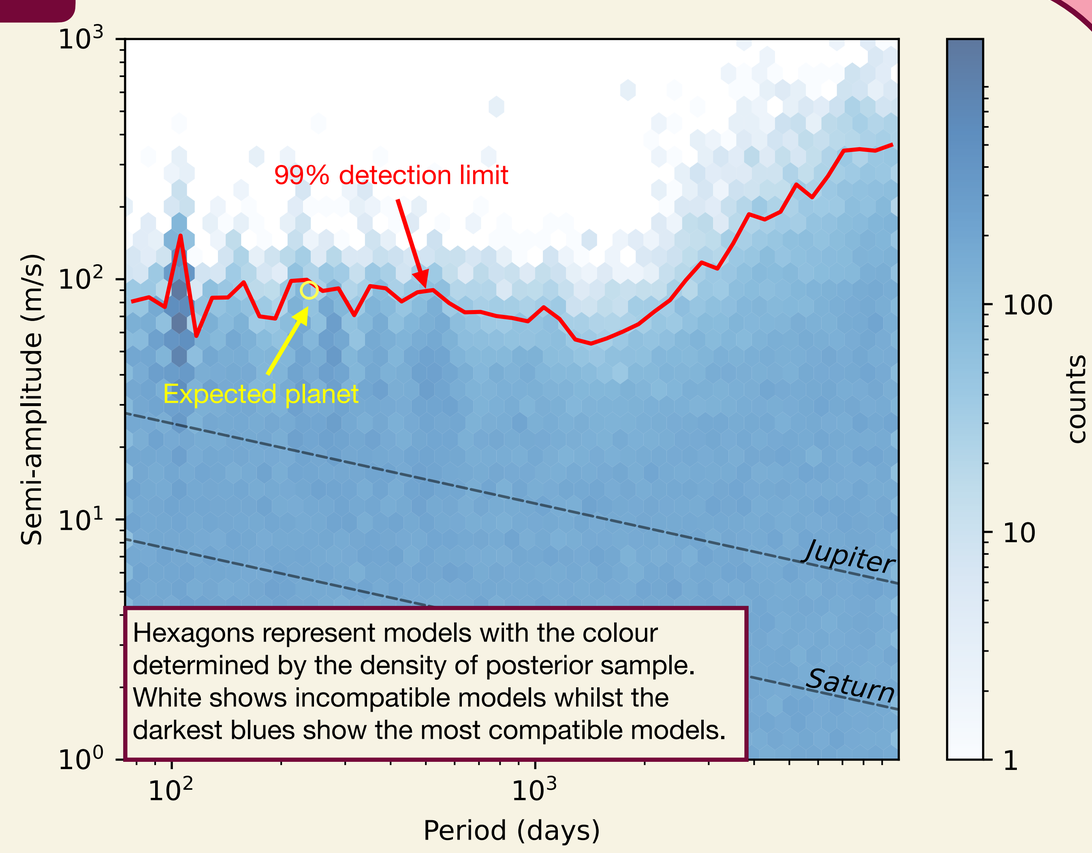
Results

KIC 5095269



Radial velocity of the primary and the secondary binary star as a function of phase with the corresponding residuals.

No planet has been detected yet.



Hex bin plot showing the density of ~100,000 posterior samples from a *KIMA* run where it is forced to find 1 planet, **despite none being formally detected**.

The red line shows the 99% detection limit and the yellow ring shows where I expect the planet to be.

Problems

- Magnitude 13.6 binary meaning the CCFs are noisy and easily contaminated by the moon.
- KIC 5095269 needs to be observed when the binaries are not eclipsing.

Conclusions

- We need to continue observations to collect more data.
- **We are close to a detection!**

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