

Effect of Stellar Rotation Period on Planet Detectability

The J'S

Sarah Millholland

Julian van Eyken

Jonathan Aguilar

Jason Wang

Joe Catanzarite

Questions

- 1) What happens if you change the rotation period of the star?
 - a) Is the activity RV signal increasing or decreasing?
 - b) Is the effect of spots bigger than the effect of plages?
 - c) How does the rotation period change the correlations between RVs and the other parameters (BIS SPAN, FWHM, photometry)?

- 2) Do you prefer a star that is rotating slower to detect exoplanets?

Hypotheses

- 1) What happens if you change the rotation period of the star?
 - a) Is the activity RV signal increasing or decreasing?
 - **Hypothesis:** RV signal will increase with decreasing rotation period
 - b) Is the effect of spots bigger than the effect of plages?
 - **Hypothesis:** effect of plages is larger
 - c) How does the rotation period change the correlations between RVs and the other parameters (BIS SPAN, FWHM, photometry)?
 - **Hypothesis:** correlations will increase with decreasing rotation period
- 2) Do you prefer a star that is rotating slower to detect exoplanets?

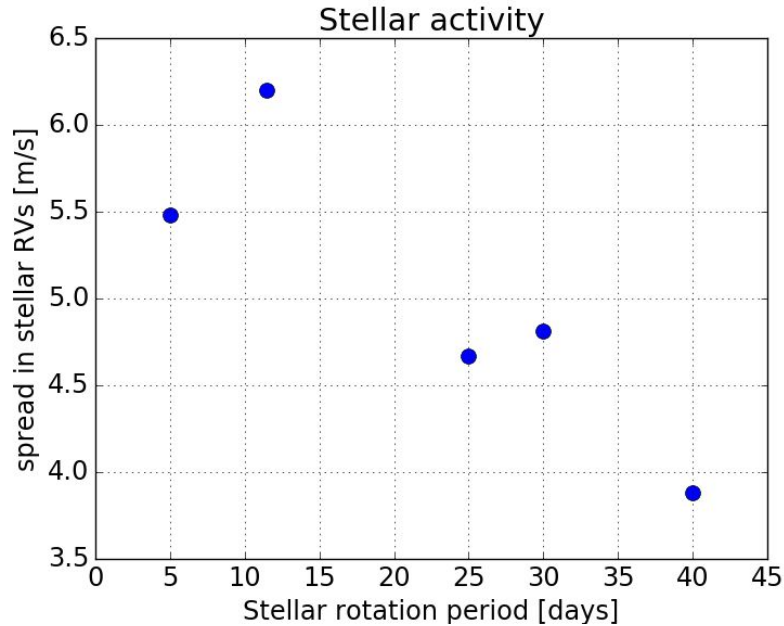
Hypothesis: A planet should be easier to detect around a slower rotating star, due to lower RV noise, but it will be harder to detect if the planet period and stellar rotation period are near harmonics of one another.

Methods

- Keep all periods except stellar rotation period the same
- Inject a planet with a 5 m/s signal at a period of 23 days
- Vary the stellar rotation period as follows

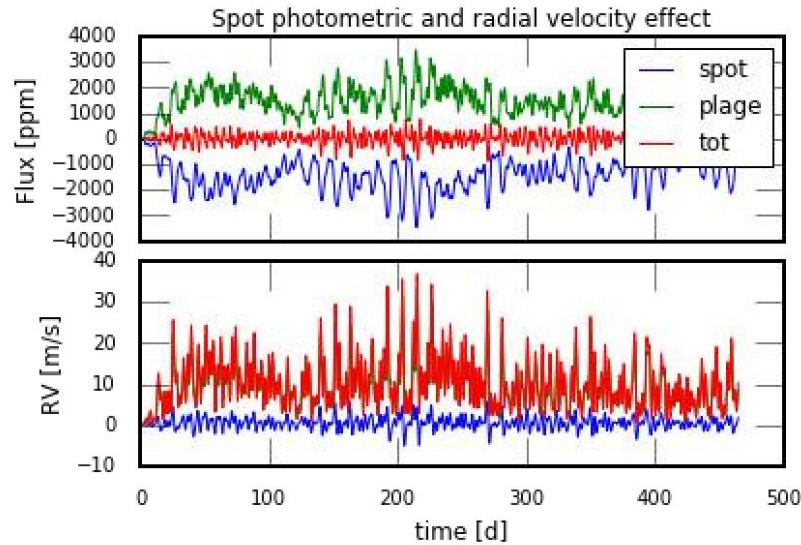
Stellar Rotation Period [days]	Description
5	Short Period
11.5	$\frac{1}{2}$ Planet Period
25	Very Close to Planet Period
30	Intermediately far from Planet Period
40	Long Period

1.a) Effect of Stellar Rotation Period on the Stellar Activity RV

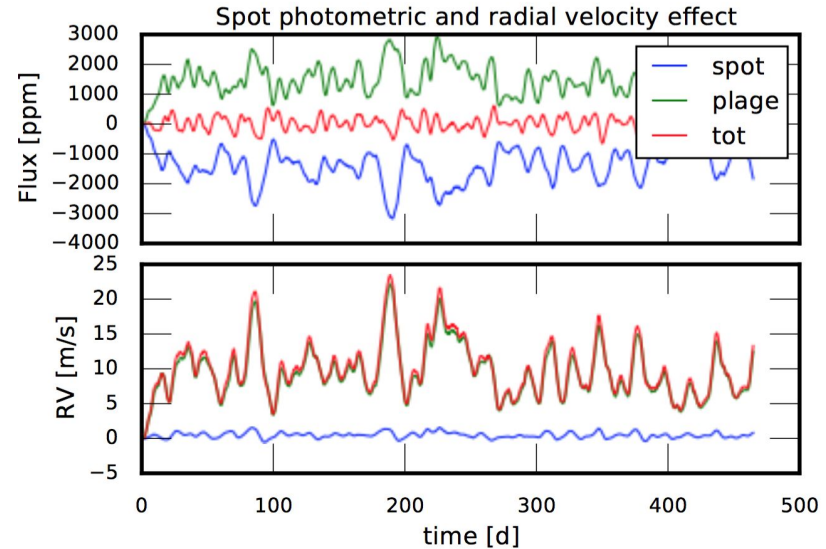


1.b) Effect of Spots and Plages on the RV signal

For 11.5 day Period Rotation

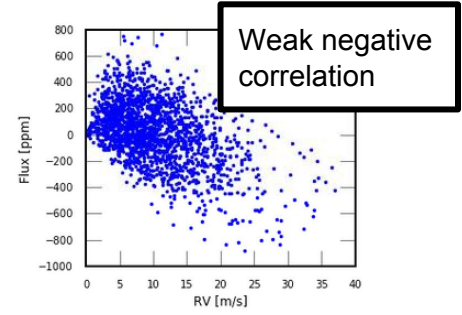
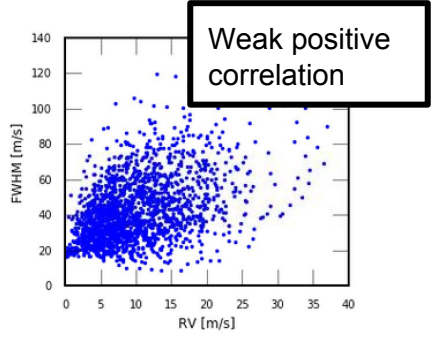
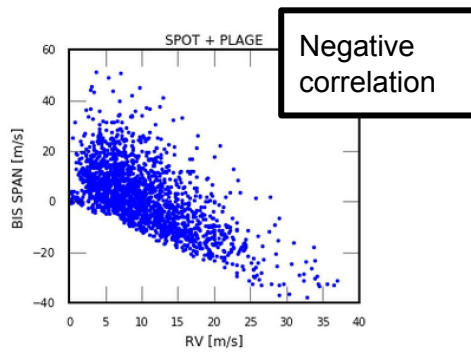


For 40 day Period Rotation

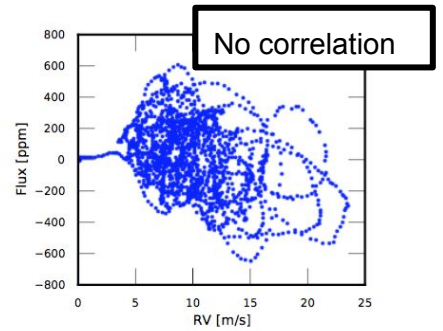
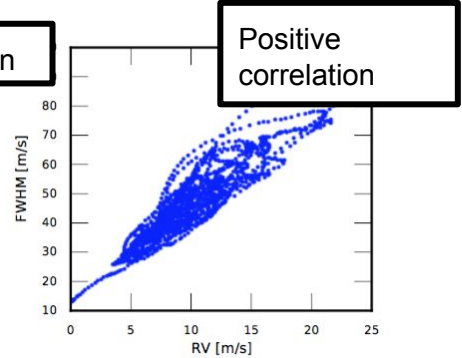
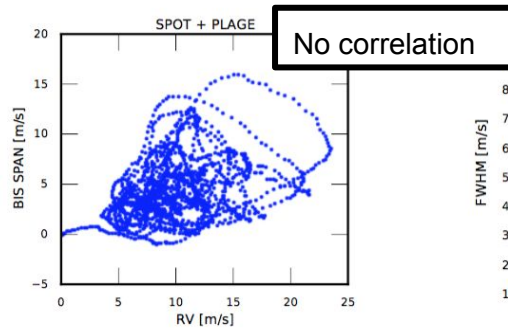


1.c) Effect of rotation period on correlations between RVs and activity parameters

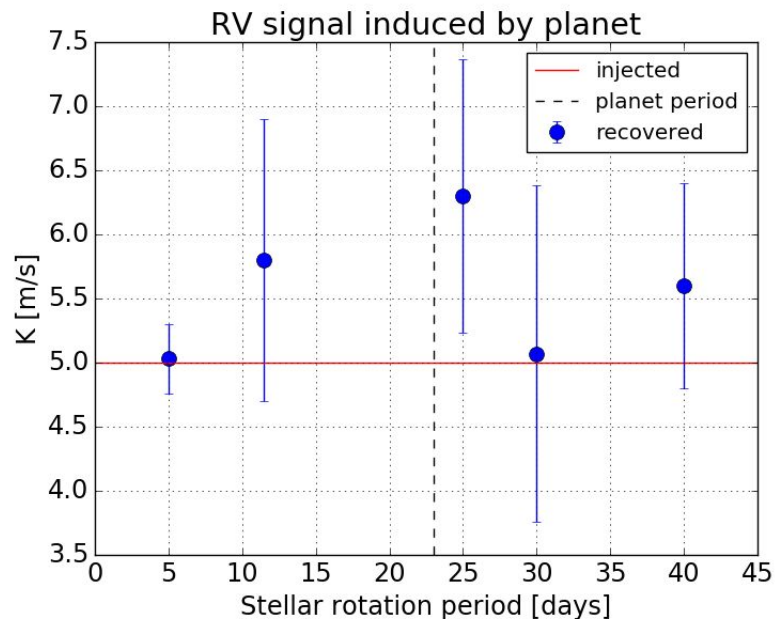
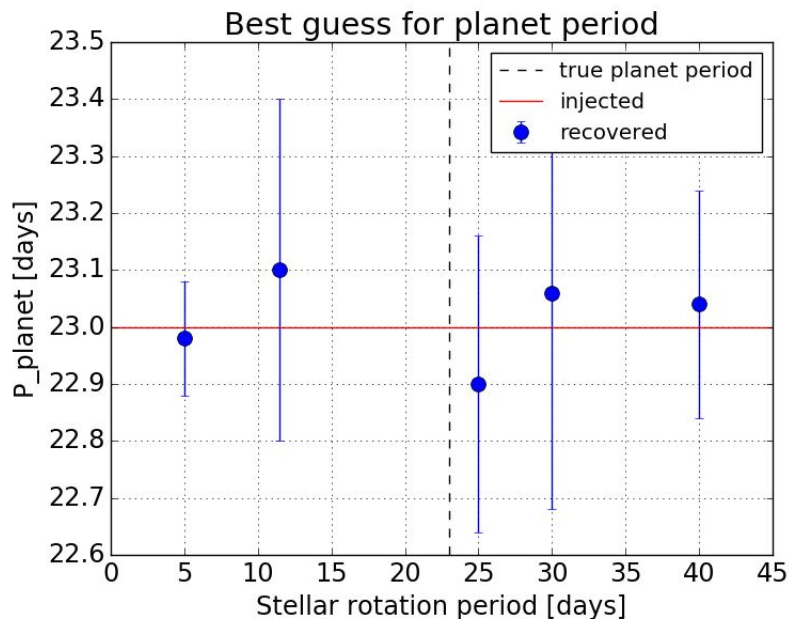
$P_{\text{Rot}} = 11.5$ days



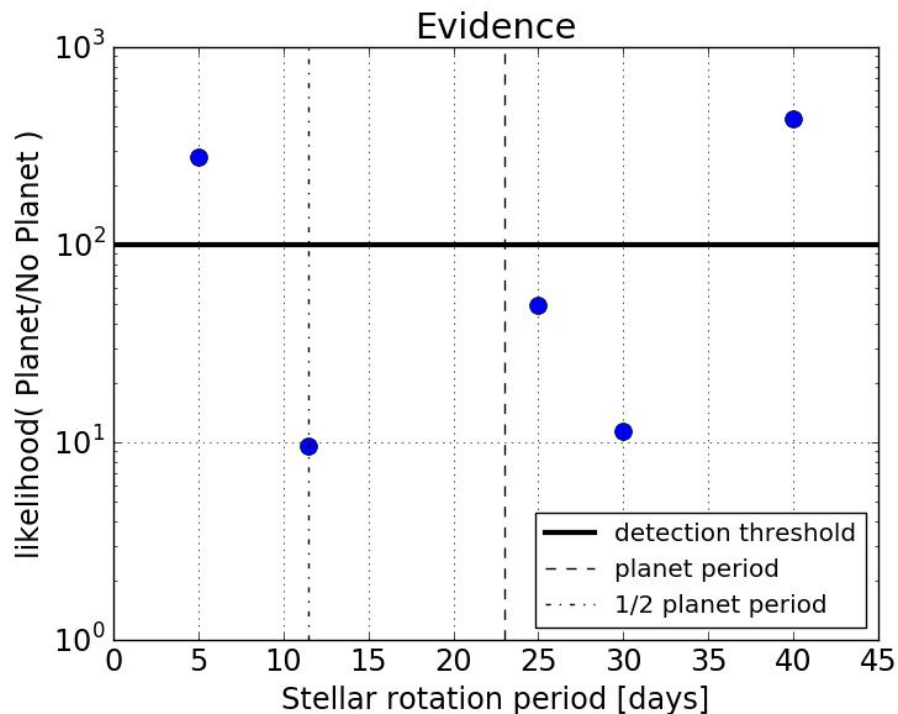
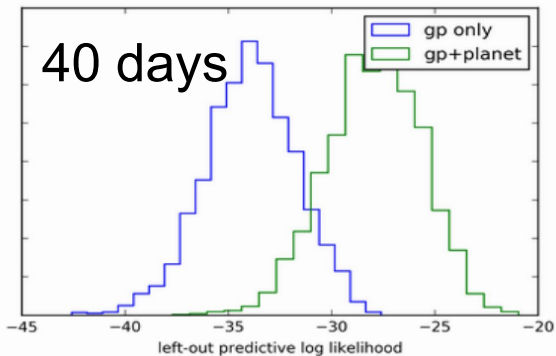
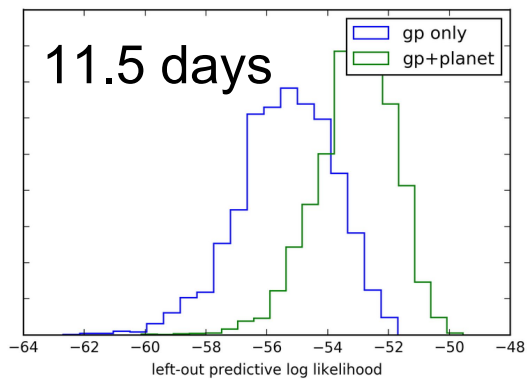
$P_{\text{Rot}} = 40$ days



2. Effect of Stellar Rotation Period on Planet Detectability



Effect of Stellar Rotation Period on Planet Detectability



Conclusions

- Stellar activity generally increases with rotation speed
- Recovery of the planet's signal is generally better the further apart the planet period is from the stellar rotation period, in both directions
- Bayesian evidence is best when the planet period is proportionally farthest from the stellar rotation period.
- Aliasing of the planet's orbital period and the first harmonic of the stellar rotation period attenuates the fitting of the RV signal and is a bigger problem for claiming detections than a small difference in period.
- Future work
 1. Use a finer grid of stellar rotation periods to more fully sample the sensitivity of Bayesian evidence to stellar rotation period. Are there other points where the evidence is low due to aliasing issues?
 2. Detect an Earth-like planet in the habitable zone around a Sun-like star