# RVxTESS : Mitigating RV Signal Induced by Stellar Jitter

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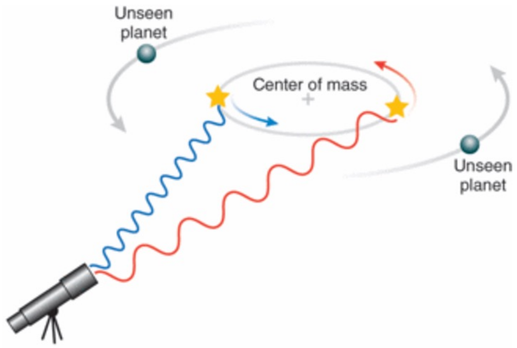
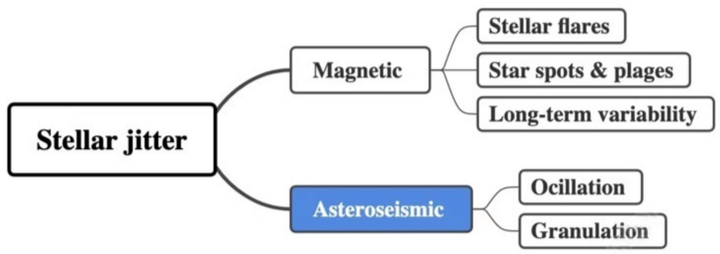
## Introduction

- The **Radial Velocity (RV)** method, measuring the Doppler Shifts from stellar spectra, is widely used for the detection and characterization of exoplanets. For Earth analogs, RV detection typically requires cm/s precision, whereas the stellar jitter becomes an issue at the m/s level.
- **Stellar jitter**, including magnetic and asteroseismic signals, refers to the stellar atmospheric variations that introduces noise to the RV measurements.



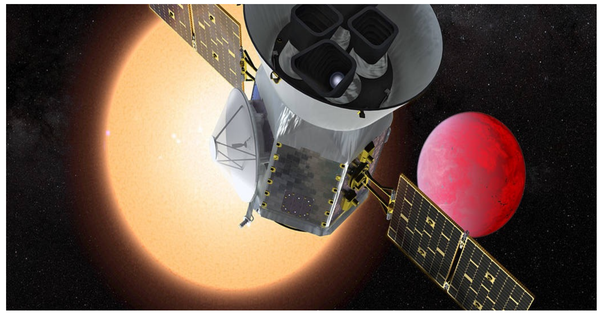



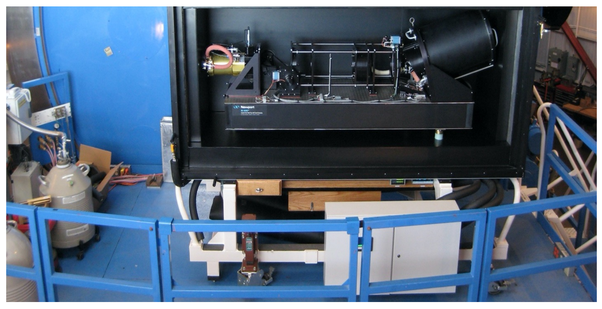

## Objectives

Use **Gaussian Process (GP)** to fit the photometric and RV signals of stellar jitter for the star HD 5562 ($M_\star$ = 0.93$M_\odot$, $R_\star$ = 2.8$R_\odot$ $L_\star$ = 2.3$L_\odot$, V = 7.16, $log(g)$ = 3.5). Particularly, we target at the asteroseismic signal in this project and plan to obtain a model to describe the stellar oscillation.
As the the photometric and RV signal for the same star are consistent in timescale and amplitude, we will first fit GP onto the star's light curve and then model the RV data, to eventually find a method to tease out RV jitter during exoplanet detection.

## Methods

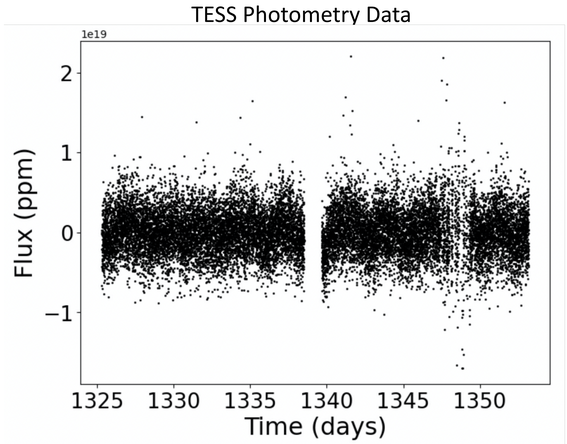
- Data: From the Transiting Exoplanet Survey Satellite (**TESS**) and the Carnegie Planet Finder Spectrograph on the Magellan II Telescope (**Magellan/PFS**). PFS is a high-resolution optical spectrograph. It is unique and crucial because of its southern location and Magellan's large aperture.
- Fitting method: **GP** is a model capable of describing correlated stochastic signals. In GP, any finite set of variables encompasses a multivariate Gaussian distribution.
- Celerite: a library of fast and scalable GP regression in 1D (Foreman-Mackey et al., 2017). It models the stellar jitter as stochastically driven simple harmonic oscillators (SHOs). Celetite allows us to evaluate the probability of the observed time series using a GP where the power spectral density (PSD) is a sum of terms given by an equation with only limited parameters.

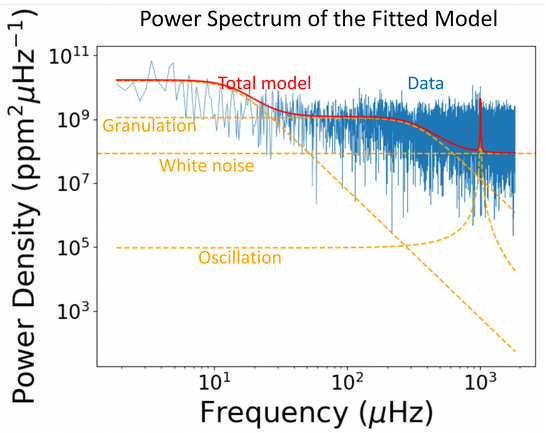




## Results

- The characteristic frequency of the oscillation is around 15 minutes, shorter than the previous prediction of 44 minutes (Kjeldsen et al., 2011) derived from its mass and luminosity.
- The model shows 2 granulation terms and 1 oscillation term with sharp peak.




## Future work

(1) fit the light curve with multiple oscillation modes.
(2) after fitting the photometric data, apply GP to the star's RV data.
(3) Test the long-term behavior of the GP model over multiple mode life times

For more information, please visit our website: **RVxTESS.com**

## Reference

Foreman-Mackey, D., Agol, E., Ambikasaran, S., & Angus, R. 2017, The Astronomical Journal, 154, 220, doi:10.3847/1538-3881/aa9332
Kjeldsen, H., & Bedding, T. R. 2011, Astronomy Astrophysics, 529, L8, doi:10.1051/0004-6361/201116789