EPRV Research Coordination Network : Fall 2022 Meeting
October 20th 2022, 8a – 12p Pacific US

8 – 9a PT : Welcome & Community Discussion on RCN Goals

Dawn Gelino [NExScI] will provide an overview of how NExSS -- NASA's astrobiology RCN -- has succeeded in supporting community science over the past seven years. We'll then open the floor for input on what roles our new RCN can play in supporting the EPRV community, and what kinds of events & collaborations participants would like to see in coming months.

9 – 9^{50} am PT : RCN Science Presentations

9 – 9^{10} am : SOAP-GPU: Efficient Spectral Modelling of Stellar Activity Using Graphical Processing Units [Yinan Zhao, Univ. of Geneva]

Stellar activity mitigation is one of the major challenges for the detection of earth-like exoplanets in radial velocity measurements. Several promising techniques are now investigating the use of spectral time-series, to differentiate between stellar and planetary perturbations. In this context, developing a software that can efficiently explore the parameter space of stellar activity at the spectral level is of great importance. A new version of the Spot Oscillation And Planet (SOAP) 2.0 code that can model stellar activity at the spectral level using graphical processing units (GPUs) is introduced. Benchmarking calculations show that this new code improves the computational speed by a factor of 60 while having the same accuracy. On top of that, we implemented a realistic simulation of activity on solar-type stars (inhibition of convective blueshift, number of active regions, evolution), therefore allowing to generate realistic spectral time-series affected by activity perturbations within seconds. The code is essential to test any algorithm that tries improving planetary signal detection by mitigating stellar activity at the spectral level. SOAP-GPU also includes more physics and is able to model different stars than the Sun, from F to K dwarfs, thanks to the PHOENIX spectral library.

9^{10} – 9^{20} am : New Periodograms Separating Orbital Radial Velocities and Spectral Shape Variation [Sahar Shahaf, Weizmann Institute of Science]

Searching for a periodic modulation in a time series of spectroscopic measurements poses many challenges. Even if periodicity is detected, one may also face the challenge of attributing it to the reflex motion of the star rather than other activity-related effects. In this talk, I will introduce new periodograms that can distinguish between Doppler shifts and spectral shape variability using partial distance correlation. The potential science cases include active planet-hosting stars on the one hand or binary systems with an intrinsically variable component on the other.

9^{20} – 9^{30} am : Modeling chromatic mode frequency shifts in astroetalons for high precision spectrograph calibration [Molly Kate Kreider, Univ. of Richmond]

Astro-etalons for radial velocity spectrograph calibration have been measured to exhibit complex, frequency-dependent mode drift over time in several systems worldwide. We have modeled possible causes of this drift in the etalon mirror coatings of the HPF and NEID etalons and have determined that the measured behavior of these two systems is likely due to an aging process in the dielectric mirror layers.

9^{30} – 9^{40} am : Stellar signal components seen in HARPS and HARPS-N solar radial velocities [Khaled Al Moulla, Univ. of Geneva]

For state-of-the-art spectrographs which are able to reach sub-m/s RV precision, stellar activity is the main limitation to the detection of Earth-like planets. By combining HARPS and HARPS-N solar data spanning several years, we are able to resolve and characterise the stellar signals seen on the Sun on timescales up to its sidereal rotational period. We use an MCMC mixture model to determine the quality of the solar data based on the expected airmass-magnitude extinction law. After rejecting variations caused by poor weather conditions, we are able to improve the average intra-day RMS value by a factor of ~1.8. We then fit the velocity power spectrum of the cleaned and heliocentric RVs with all known variability sources, to recreate the RV contribution of each component. On sub-rotational timescales, we are able to fully recreate the observed RMS of the RV variations. In order to also include rotational components and their strong alias peaks introduced by nightly sampling gaps, the alias powers are accounted for by being redistributed to the central frequencies of the rotational harmonics.

9^{40} – 9^{50} am : Working towards a coordinated, global survey of RV standards in 2023B [Jennifer Burt [JPL]

Quasi-simultaneous precision RV observations of stars taken with multiple facilities can provide useful insights into how stellar phenomena manifest across different instruments and data reduction pipelines. Yet obtaining time to observe such stars stars at high cadence without an immediate science return can be a challenging concept to get through our (often highly competitive) TACs. I propose an RCN effort to establish a multi-instrument survey of a handful of carefully selected RV stars, where the observing proposal would be developed within the RCN and then submitted to multiple RV instrument TACs with an emphasis on the global nature of this effort and the investigations that could be carried out using such a rich data set.

9^{50} – 10 am Coffee Break!

10 – 11a PT : Multidimensional Gaussian Processes applied to spectroscopic time series with pyaneti [Oscar Barragan, Univ. of Oxford]

Active regions on stellar surfaces induce signals in radial velocity (RV) time series that limit our ability to detect planetary signals. In order to detect planetary-induced RV signals, we need to perform informed modelling of the stellar activity. The use of spectroscopic activity indicators is useful to understand the behaviour of stellar signals in RV data. However, the stellar activity manifests with different behaviour and shapes in different spectroscopic time series. Therefore, the use of activity indicators to inform the modelling of the stellar signal in the RV data has to be taken carefully. In this contribution, we discuss how a multidimensional Gaussian Processes framework can be used to constrain the stellar signal in multiple spectroscopic time series. We will learn how to use open source code pyaneti in order to set up a multidimensional Gaussian Process regression to model the stellar and planetary signals of the young K2-100 star. This setup will be easily modifiable to datasets of other active stars.

Note: Visit https://github.com/oscaribv/pyaneti/wiki for instructions on how to install *Pyaneti* ahead of the meeting to allow full participation in Oscar's tutorial!

11a – 12p PT : EPRV Networking

Developing connections and building bridges between people / departments is a major goal of the RCN. We'll be setting up a variety of small group conversations between participants to foster new ties between members of all career levels.

Connection details at: https://exoplanets.nasa.gov/exep/NNExplore/EPRV-RCN