Terms of Reference for ExoPag SAG21 on

The Effect of Stellar Contamination on Space-based Transmission Spectroscopy

Motivation

Transmission spectroscopy is a method for identifying the atmospheric composition of an exoplanet by measuring a wavelength-dependent radius of a planet as it transits its star. This technique has been successfully applied to many exoplanets, primarily using HST and Spitzer, but also using ground-based telescopes. Most transmission spectroscopy studies to date have targeted gas giant worlds due to their larger expected signatures, which scale with the planet's atmospheric scale height. During the next two decades, and thanks to the next generation of ground- and space-based observatories, the technique is expected to also be a major source of information on the atmospheres of rocky exoplanets.

Transmission spectroscopy relies on a precise understanding of the wavelength-dependent brightness of the star being occulted. Unfortunately, stars are not homogeneous, constant light sources but have temporally evolving photospheres and chromospheres with inhomogeneities like spots, faculae, and plages. The surface features of the star change both intrinsically as active regions evolve and from the perspective of an observer as the star rotates. Spots and faculae have different temperatures from the disk-averaged photosphere, and for cooler stars, can have molecular features distinct from the star itself but similar to those in a planet's atmosphere (e.g. H_2O). Some studies have found that the signal from stellar inhomogeneities can exceed the signal from the planetary spectral features. To make the most of future NASA facilities like JWST, it is essential we quantify the impact of stellar contamination on transmission spectroscopy and develop methods to mitigate for it.

Goals

This SAG will bring together an interdisciplinary team of scientists, with observers and theorists from the heliophysics, stellar astrophysics, planetary science, and exoplanetary atmosphere research communities, to address both the impact of stellar contamination on transmission spectra and constraints on stellar photospheric heterogeneity enabled by transiting exoplanets.

The goals of this SAG are to:

1. Report on what effect stellar contamination could have on future space-based transmission spectroscopy measurements;

2. Identify regions of the parameter space in which care should be exercised with respect to stellar contamination in the context of transmission spectroscopy studies;
3. Identify measures that can be taken to understand the magnitude of stellar contamination;
4. Identify what modeling efforts can further our understanding of stellar contamination;
5. Develop methods to identify measurements that might be contaminated; and
6. Pinpoint complementary observations that can be combined with transmission spectroscopy to mitigate or correct for stellar contamination.

Methods

The SAG will primarily coordinate its actions through Slack. We will also regularly meet online with all SAG members and any interested or invited guests.

Deliverables

The SAG will report progress to the ExoPAG every two months, will document its findings in one or more publications, and will deliver a white paper to the Agency in mid-2021.