WFIRST Exoplanet Coronagraph and Starshade: Prospects for Detecting and Constraining the Properties of Nearby Habitable Worlds.
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Introduction: The WFIRST Coronagraph Instrument (CGI) will enable the first space-based program to directly image planets orbiting the nearest sunlike stars and to spectroscopically characterize their atmospheres at optical and near-IR wavelengths [1]. The mission responds to the highest ranked medium-scale priority in the *New Worlds, New Horizons* 2010 decadal survey, laying the "technical and scientific foundation for a future mission to study nearby Earth-like planets," by demonstrating advanced starlight suppression techniques in space [2]. WFIRST is expected to enter Phase B in 2017, and remains on schedule for a launch in 2025. For the exoplanet community, this represents our best opportunity to explore the configurations and characteristics of our neighboring planetary systems – including their potential habitability to life as we know it -- until at least the 2030s.

In addition to the coronagraph, WFIRST is now baselined to accommodate the addition of a separately launched starshade. This is good news for those of us interested in habitability and biosignatures, because in addition to expanding the WFIRST planet detection space it will pave the way for larger missions to incorporate the use of starshades. Operating in tandem with the coronagraph, a starshade would enable the detection and spectral characterization of fainter planets at both smaller and larger separations from target stars -- including Earth- and super-Earth-sized planets within the habitable zones of the most favorable targets. This capability would enable the mission to build on the important *Kepler* discovery that 1−4 Earth radii planets – so-called "super-Earths" and "mini-Neptunes" – are extremely common [3].

In this presentation, we will provide (1) a brief mission status update, (2) an assessment of WFIRST's capability to discover Earth-sized worlds orbiting within the habitable zones of specific star systems, and (3) a preliminary analysis of how well these data will allow us to characterize those worlds in terms of habitability and biosignatures.

Detecting Habitable Worlds: Our WFIRST Science Investigation Team (SIT) is tasked with characterizing the most favorable targets for imaging a large diversity of planets. We will present our assessment of the discovery space available to WFIRST (in terms of planet sizes and temperatures), and we will describe the stellar systems that are mostly likely to yield interesting fruit in the search for habitable worlds.

Characterizing Habitable Worlds: Understanding how to translate WFIRST spectral data products (at realistic signal-to-noise ratios and spectral resolution) into real insights about planetary properties is a key ongoing component of the mission development. As part of our WFIRST SIT's Starshade Accommodation effort, we have developed a framework to simulate optical and near-IR reflectance spectra of Earth analog exoplanets. The framework is designed to be flexible in terms of the observation and stellar system geometry, exoplanet atmospheric composition, and radiative transfer modeling. We will describe the use of this framework for generating simulated WFIRST photometry and spectra for Earth analogs orbiting specific targets, and we will present our initial results in retrieving planet characteristics from those data.

References:

[1] D. N. Spergel et al., "WFIRST-AFTA 2015 report," (2015), http://wfirst. gsfc.nasa.gov/science/ sdt_public/WFIRST-AFTA_SDT_Report_150310_ Final.pdf (8 March 2016).

[2] National Research Council 2010, New Worlds, New Horizons in Astronomy and Astrophysics (Washington, DC: The National Academies Press).

[3] Batalha, N. M., Rowe, J. F., Bryson, S. T., et al. (2013). ApJS, 204, 24.