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On the Taxonomy of Exoplanets using Traditional and Novel Spectroscopic Techniques

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To address the questions of habitability and the presence of life outside our solar system, we need to better understand the atmospheric processes of these worlds as well as the processes driving the formation and evolution of planets and planetary systems. Most exoplanets found to date have been discovered via the transit method, and transmission and emission spectra represent the primary method of studying these distant worlds. With current signal-to-noise considerations, hot Jupiters are easier to observe than smaller planets and will help to lay the foundation upon which to better understand atmospheric processes and system evolution, though data from future telescopes will reveal much about smaller exoplanets.

As part of the PanCET program, we have conducted a spectroscopic study of the hot Jupiter WASP-79b. We examined HST/WFC3 (1.125-1.650 microns), Magellan/LDSS-3C (0.6-1.0 microns), and Spitzer (3.6 and 4.5 microns) data. Using these data, we constrained the water abundance (log(H2O)) to be between -2.20 and -1.55. We will present these results along with an atmospheric retrieval analysis, which favors inclusion of FeH and H- in the atmospheric model. With the detectable water feature and its occupation of the clear/cloudy transition region of the temperature/gravity phase space, WASP-79b is a target of interest for the approved JWST Director's Discretionary Early Release Science (DD ERS) program, with ERS observations planned to be the first to execute in Cycle 1. We will also present simulated JWST transmission spectra deriving realistic abundance constraints.

Current methods of characterizing transiting exoplanets entail the use of spectrographs on large telescopes, requiring significant observation time to study each planet. However, previous studies have shown promising trends in solar system planets using reflectance color analysis. Building on these concepts, we have investigated the use of transmission color analysis for coarse categorization of exoplanets and for assessing the nature and habitability of these worlds, with a focus on resolving the mass/radius degeneracy to aid in discriminating super-Earths and sub-Neptunes. Our results indicate the ability to distinguish between these classes of planets with high accuracy using just a few specific low-resolution filter combinations. This method could allow for broad characterization of a large number of planets much more efficiently than current methods permit, as well as inform follow-up observing time of large telescopes for more detailed study of worlds of interest. We will present the results of this investigation.