NEAR-INFRARED OBSERVATIONS FOR THE CHARACTERIZATION OF EXTRASOLAR PLANETS

R. L. Jackson[1] and R. Strausbaugh[2], [1]Arizona State University – School of Earth and Space Exploration, [2]Arizona State University – Department of Physics.

Introduction: In the last 20 years, the rate of discovery of exoplanets has grown exponentially, which is the reason that there are nearly 3,500 confirmed exoplanets today. The next step in exoplanet research is characterization of their structure, composition, and atmospheres. To this end, transit photometry is of particular importance because the measurement of the transit depth, is currently the only method through which an exoplanet's radius can be determined. Combined with radial velocity measurements, which determine the mass of the exoplanet, the average density can be estimated. The bulk density indicates the thickness of the atmosphere and interior [1][2] but there can still be ambiguity in the chemical composition, especially in Neptune-sized planets [3].

The challenge now is determining the chemical composition of exoplanet atmospheres. Transit photometry can also potentially lead to characterization of atmospheres, both in the primary transit through which a transmission spectrum [4] can be measured and in a few cases, in the secondary eclipse when an emission spectrum [5] is detectable. Although hundreds of transiting exoplanets have been discovered, fewer than 20 systems have published measurements of transmission spectra. This spectral data is vital to understanding the physical properties and activity of atmospheres on other worlds as well as determining the viability of life on these worlds. Determining the atmospheric composition of planets of intermediate size between terrestrial and ice giant will also differentiate between different interior structural models [3]. For example, GJ-1214b has 3 distinct interior models due to an intermediate bulk density and a substantial atmosphere. These models are characterized by significant differences in chemical composition and each model would indicate a substantially different origin, both for the atmosphere itself and the star system as a whole [6].

Rather than attempting to characterize an atmosphere at all wavelengths, which is necessary for the full characterization of a planet's atmosphere, we instead focus on the near-infrared (NIR) as it is very sensitive to the effects of different compositions such as varying C/O ratios [7] and Solar or metal-enhanced compositions [8].

A key part of our observations is to not only characterize exoplanetary atmospheres but also provide a proof of concept that commercially available InGaAs, near-infrared (NIR) arrays have significantly reduced the dark current and thermal noise such that they are now a much lower cost alternative to HgCdTe detectors. This opens the door to NIR observations of exoplanets by arrays of telescopes, which will almost eliminate the detrimental effects of Earth's atmosphere which limit our photometric precision. At Arizona State University, we have designed a system using an off-the-shelf 0.457 meter telescope and a Short-Wave InfraRed (SWIR), InGaAs camera. We are also making observations in conjunction with RATIR at the National Observatory of Mexico to provide positive evidence for our system and to propose for 3 more of these cameras to be deployed on other small, established Earth- based telescopes to create an array based on the system developed at ASU. Such an array would create new opportunities to search for habitable worlds outside our solar system.

References: [1] Helled et al. (2015) *arXiv:1505.00139v2*. [2] Moutou et al. (2015) *C. R. Geoscience*, 347, 153-158. [3] Bean et al. (2011) *arXiv:1109.0582v2*. [4] Charbonneau, D. (2002) *arXiv:astro-ph/0209517*. [5] Charbooneau, D. et al. (2005) *ApJ*, 626, 523-529. [6] Rogers, L. A.and Seager, S. (2010) *ApJ*, 716, 1208. [7] Madhusudhan, N. (2012) *ApJ*, 758, 36. [8] Burrows et al. (2008) *arXiv:0803.2523v2*. [9]