JVLA AND ALMA OBSERVATIONS OF THE J1407B EXORING SYSTEM. Jacqueline Monkiewicz[1] , Matthew Kenworthy[2], Pamela Klaassen[3], and Eric Mamajek[4,5], [1]School of Earth and Space Exlporation, Arizona State University, PO Box 876004, Tempe, AZ 85287 (jmonkiew@gmail.com), [2]Leiden Observatory, Leiden University, [3]UK Astronomy Technology Centre, Royal Observatory Edinburgh, [4]Jet Propulsion Laboratory, [5]California Institute of Technology.

Introduction: In 2007, a 54-day eclipsing event of the pre-main sequence star 1SWASP J1407 revealed the presence of a large (a ~ 1 A.U.) exoring system encircling a presumed substellar companion, dubbed J1407b[1]. Multiple ring crossing events suggest a highly-structured, dusty system. Given the age of the host star, the most favorable interpretation is of a proto-satellite disk system left over from the nebular accretion phase of the companion, with the disk possibly sculpted by young exomoons. No additional eclipses have since been observed; consequently the orbit, size, and dust mass of this exoring system remain largely unconstrained.

Only the Atacama Large Millimeter Array (ALMA, Chajnantor Plateau, Chile) and the Jansky Very Large Arrray (JVLA; Magdalena, New Mexico) have adequate sensitivity and resolution to directly detect and potentially map the orbit of the exoring system. We will obtain JVLA Q-band (45 GHz) observations and ALMA band 7 (345 GHz) observations in order to 1.) confirm the presence of an early exoring system orbiting J1407, 2.) measure emission from the larger millimeter- and centimeter-sized dust particles, and 3.) constrain the total dust mass of the exoring system and measure the particle size distribution. If detected, these will be the first direct observations of an exo-satellite system in the process of formation, and could provide astrometric data to determine the epoch of the next eclipse.

Theoretical Expectations: The ability of ALMA and JVLA to detect the exoring system depends both on the temperature of the dust and on the precise distribution of dust particle sizes. ALMA band 7 is primarily sensitive to millimeter-sized grains, while JVLA Q-band is primarily sensitive to centimeter-sized grains. The sharp structure of the ring system seen during the 2007 eclipse points to a very thin, dynamically cold ring [2][3], which is the sort of environment that could foster the growth of large grains.

Simulations of a r = 1 A.U., T = 70K dust disk from MCMAX (M. Min; [4][5]) suggest that such a system is well within the ALMA detection limits. JVLA observations are more challenging, but potentially offer the chance to resolve the orbit of the exoring system around the stellar primary.

Simulated Observations: We use the CASA suite of software to produce model observations of the U-V coverage and point-source function for possible 3-5-hour observation in ALMA band 7, and for a 1-2 hour observation with JVLA Q-band.

The JVLA observations are much more challenging, due to the extremely southern declination (δ ~ -39°). Maximum observation length is set by the elevation limit of the telescope and practical constraints of observing through more of the Earth's atmosphere at Q-band frequencies. Tropospheric water vapor creates large phase shifts in the observed signal, making it difficult to calibrate or image interferometeric data. Phase interference from tropospheric water vapor is much more of a problem for the JVLA observations, and necessitates rapid switching on 90-second intervals between the science field and a nearby radio-bright phase calibrator to achieve the desired sensitivity.

Despite these observation challenges, the JVLA in its largest configuration (A-configuration) actually has higher angular resolution. While ALMA is our best chance at detecting the exoring system, JVLA offer our best chance to separately resolve the exoring and stellar primary and map the orbit directly.

Observational Status: A-configuration JVLA observations were awarded A-priority are currently in progress with 3.5 hours taken to date. Due to the large overhead associated with high-frequency, low elevation JVLA, this equates to approximately 40 minutes on-source. The J1407b system was not apparent in an initial imaging of the first 10 minutes of data from the JVLA, which suggests it is not bright enough at these frequencies to self-calibrate the signal phase. We will therefore need to continue our rapid switching technique between the phase calibrator and the science field.

ALMA observations will commence during spring of 2017.

References:

[1] Mamajek et al. 2012, *AJ*, 143, 73. [2] Kenworthy & Mamajek, 2015, *ApJ*, 800, 126. [3] van Werkhoven et al. 2014, *MNRAS*, 441, 2845. [4] Min et al. 2005, *A&A*, 432, 909. [5] Min et al. 2009, *A&A*, 497, 155

Acknowledgements: J. Monkiewicz's work on this project is supported by a grant from the NRAO Student Observing Support program.