Search for Planets Transiting Bright M Dwarf Stars—Field 1

C. Beichman, D. Ciardi, P. Plavchan, J. Christiansen (NExScI), G. Vasisht (JPL), S. Howell (Ames)

ABSTRACT: We have carefully constructed a sample of M stars from the WISE, 2MASS and SIMBAD catalogs. Using a Monte Carlo simulation we have chosen 1,328 stars with the highest probability of detecting a transiting planet with periods between 1-37.5 days (at least two transits in a 75 day stare period) and radii between 1-3 R_{Earth}. We anticipate being able to find 35 planets orbiting stars with spectral types from M0-M6.

Catalog Criteria: We searched the 2MASS and WISE catalogs in a 12 degree box centered on Field-1. Starting with initial JHK color and SNR criteria, we selected 2MASS objects with no blending or source confusion, no galaxy contamination, and no other 2MASS object within 10". An optical match, if present, was used to provide B and R magnitudes. With the resultant 2MASS source list as input to the WISE catalog, we used WISE to retain only objects with WISE1-WISE2 and WISE2- WISE3 (if present) colors consistent with stellar values, thereby excluding many galaxies or objects with mid-IR excesses. We used 2MASS-WISE positions to derive proper motions (or limits) over a >10 year baseline to help discriminate between main sequence objects and other luminosity classes. This process led to 41,069 objects brighter than J<15.5 mag. After a multi-color fit to R-J,J-H,H-K,J-W1,J-W2, W1-W2 colors (Kirkpatrick et al 2011; Pecaut & Mamajek, 2012) and reduced proper motion magnitudes, we were left with 9,914 M dwarf candidates. In addition to these objects we included another ~200 bright M stars identified in the SIMBAD for a sample of 10,106 objects (Figure 1). The final step in the process was to select those objects most likely to show a detectable transit. We ran a Monte Carlo simulation with 500 trials per star to select those objects most likely to yield a detectable transit. While early spectral types are brighter, their larger stellar radii result in lower transit depths for the small planets (1-3 R_{Earth}) considered here. Conversely, fainter, later spectral types can be favorable because of their smaller radii. The result of this selection via simulation is a list of 1,328 target stars.

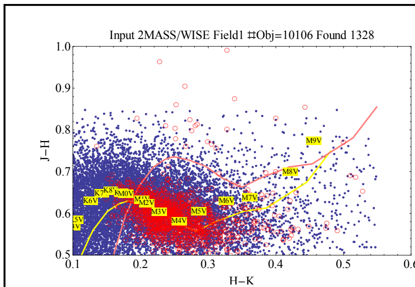

Figure 1. Blue dots represent a sub-sample of the initial 41,000 M star candidates. The red dots show the final sample of 1100 objects.

Survey Yield: For our simulation we took plausible radius and period distributions for M star planets, e.g. Dressing & Charbonneau (2010), and a nominal K2 noise floor of 80 micro-mag in 6 hr for a 12 mag star. We assumed the photon-noise limit at fainter magnitudes (Jenkins et al 2010), an integration time equal to the transit duration, and required a final SNR >7.1 after N$\geq$2 transits. While K2's noise performance has not been fully demonstrated, we are prepared to use the decorrelation techniques we have already demonstrated (Clanton et al 2012) to remove flat field errors to reach close to the photon noise limit. Under these assumptions we anticipate being able to find 35 planets as shown in Figure 2. We will follow these objects up with a variety of ground-based telescopes for confirmation and characterization.

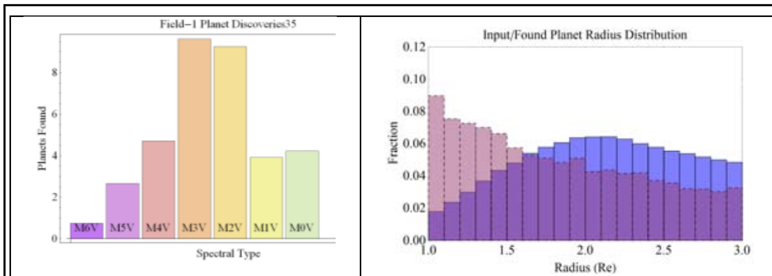

Figure 2. left) Detected planets as a function of host star spectral type; right) histogram showing distribution of planet radii (Red is input sample; blue is detected sample).

References: Clanton et al 2010, PASP,124,700; Dressing & Charbonneau, 2010, ApJ,767,95; Jenkins et al 2010, ApJ, 713,120; Kirkpatrick et al 2011, ApJS, 197,55; Pecaut & Mamajek, 2012, ApJS, 208,9.