Targeting M dwarfs with K2

Ben Montet, Andrew West, Phil Muirhead, John Johnson, Jon Swift, Andrew Vanderburg

One of the primary goals of the *Kepler* mission was to “Determine the abundance of terrestrial and larger planets in or near the habitable zone *of a wide variety of spectral types of stars.*” However, ~70% of *Kepler*'s target stars had masses within 20% of the Sun's, while 70% of the stars in the Galaxy have less than 50% the mass of the Sun (Batalha et al. 2010; Brown et al. 2011). Of the 190,000 *Kepler* stars with at least one quarter of observations, only 5500 are M dwarfs, and only 2400 M dwarfs were observed during all 16 *Kepler* observing quarters. Expanding the sample of M dwarfs will allow us to probe the smallest planets accessible to K2 while broadening our understanding of planet populations around the most numerous and closest stars in the Galaxy.

The *Kepler* science team has identified M dwarfs as a vital set of targets for the K2 mission. Two of the first three “science motivation” topics on the K2 website are to “provide a yield of small planets around bright and small stars in order to facilitate...follow-up measurements” and to “identify locations and characteristics of potentially-habitable planets around bright M dwarfs in the solar neighborhood.” This has been borne out in the Field 0 selections, with approximately 2,000 late-type stars being selected for observations. Here, we provide a list of 9,200 M dwarfs that could be observed in Field 2 or 3 to further the K2 mission goals.

Howell et al. (2014), suggest that 16$^{\mathrm{th}}$ magnitude stars appear to have noise levels 3 times that of *Kepler*. Fine pointing tests have improved on this slightly, and we have found in our own detrending efforts that we can remove at least as much instrumental noise as the K2 team (Figure 1). Thus, we select targets as faint as 17th magnitude in *r*-band, which we use as a proxy for Kp. We expect to detect planets down to 1.3 Earth radii, the most common type of planet around M dwarfs (Morton and Swift 2013). We note that the level of residual noise in our detrending efforts is a strong function of stellar position, perhaps due to the larger apertures required to encapsulate the full stellar flux on the outer modules of the detector (Figure 1).

For out previous Field 1 target selection we used SDSS data. Unfortunately, these data do not exist for Fields 2 and 3. Instead, we cross the 2MASS catalog of point sources (Cutri et al. 2003) with proper motions from UCAC4 (Zacharias et al. 2013) and *r*-band data from the 15th edition of the Carlsberg Meridian Catalogue.

Field 3 is located at a high galactic latitude, and therefore has few giant stars, and few stars with significant reddening. As a result, target selection for this field is straightforward. We first select all objects with CMC $r <$ 17 and “high-quality” *J* and *K*-band 2MASS photometry**.** To separate dwarfs from giants, we then make a cut both in color-color space and in proper motion. All our targets have $0.7 < J\text{-}K < 1.1$ and $r\text{-}J > 2.0$, as well as a proper motion greater than or equal to 5 mas/yr. The end result is a total of 3,953 targets on silicon.

Field 2 is near the galactic plane. While the same cuts should theoretically remove all giants, both interstellar reddening and faint star photometric uncertainties push giants into our sample, so we make more conservative cuts. Here, we require $r\text{-}J > 2.32 + 1.7(J\text{-}K\text{-}0.7)$ and $0.7 < J\text{-}K < 1.1$. Such cuts remove giants at the expense of a few early M dwarfs. The end result is a total of 5,226 targets on silicon.

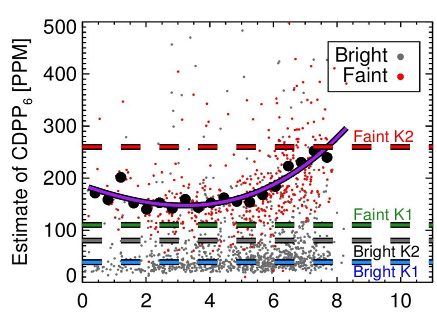

Figure 2: Bright (Kp < 12; gray) and faint (14 < Kp < 15; red) K2 test targets, with our estimated CDPP. CDPP for our faint targets depends on location and is on average lower than Howell et al. (2014).

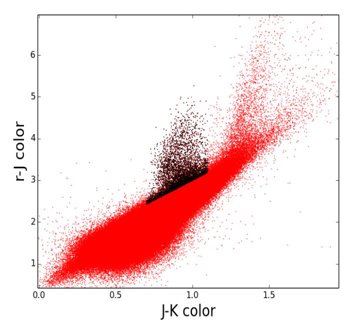

Figure 1: All stars in Field 2 (red) and M dwarfs selected in our sample (black)

References

Batalha, N. M. et al. 2013, ApJS, 204, 24
Brown, T. et al. 2011, AJ, 142, 112
Cutri et al. 2003, 2MASS All-Sky Catalog
Howell, S. B. et al. 2014, arXiv:1402.5163
Morton, T. D. and Swift J. J., arXiv:1303.3013
Zacharias et al. 2013, AJ, 145, 44