A Search for Small Planets in and near the Habitable Zones of Small Stars

C. D. Dressing[1], J. Irwin[1], and D. Charbonneau[1]
[1]Harvard Smithsonian Center for Astrophysics, Cambridge, MA, USA

Scientific Objective: *Kepler* and ground-based surveys have revealed that small planets are common around low-mass stars (Bonfils et al. 2013 A&A 549 A109; Howard et al. 2012 ApJS 201 15; Dressing & Charbonneau 2013 ApJ 767 95; Gaidos 2013 ApJ 770 90; Kopparapu 2013 ApJL 767 L8), but the occurrence rate of small planets around later M dwarfs is not well constrained. We propose to observe a sample of 2329 late K and M dwarfs with K2 in order to find additional planets and investigate whether small planets are as common around later M dwarfs as around early M dwarfs. In addition to revealing the presence of transiting planets, the K2 light curves of these low-mass stars will enable studies of stellar rotation, flares, and spot activity. Improved knowledge of stellar activity will aid efforts to understand the environments experienced by planets orbiting low-mass stars and to disentangle stellar signatures from planetary signals in radial velocity measurements.

Advantages of Observing Low-Mass Stars: Low-mass stars are particularly attractive targets for the K2 mission because their cooler temperatures and smaller radii will permit the detection of potentially habitable planets during the 80-day mission. The inner edge of habitable zone for the stars in our proposed target list ranges from 11-133 days, providing K2 with the opportunity to detect multiple transits of a potentially habitable planet.

Target Selection: The majority (1840) of our targets were chosen by cross-matching the Isaac Newton Telescope Photometric H-Alpha Survey (IPHAS) to the Two Micron All Sky Survey. The remainder (489) are from the Lepine and Shara Northern Stars Proper Motion catalog and Lepine & Gaidos (2011 AJ 142 138). We selected low-mass dwarfs by applying color cuts and reduced proper motion cuts. We assigned stellar parameters by comparing the available optical and near-infrared photometry to Dartmouth stellar models (Dotter et al. 2008 ApJS 178 89; Feiden et al. 2011 ApJL 740 L25) and incorporating distance estimates from trigonometric or photometric parallaxes. We then estimated V-band magnitudes for targets without V-band photometry and estimated the expected noise using the scaling relations from Jenkins et al. (2010 ApJL 713 L120) assuming a noise level of 87 ppm for a V=12 star. We selected all stars brighter than V=18 for which a 5 Earth radius planet in a 20-day orbit would be detectable at 3 sigma. Our proposed sample includes 672 stars cooler than 3500K, 1150 stars between 3500-4000K and 507 stars between 4000-4500K. We have listed our proposed targets in order of decreasing predicted signal-to-noise ratio for an Earth-radius planet in a 20-day period.

Sensitivity to Small Transiting Planets: Assuming that two transits are required for detection, 356 of our stars should permit the detection of planets smaller than 1.5 Earth radii in the habitable zone and 437 would permit the detection of larger planets in the habitable zone. At shorter periods of 20 days, K2 should be able to detect planets smaller than 1.5 Earth radii around 683 stars and planets smaller than 4 Earth radii around 2097. Our targets are concentrated toward the galactic plane due to the IPHAS survey boundaries, so the anticipated planet yield from our targets is highly dependent on the final position of the Campaign 0 field. In order to maximize the planet yield, we would advocate shifting the Campaign 0 field toward RA=6h.