Observations of very low-mass dwarfs with Kepler-2

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Science justification and target selection

Kepler-2 provides a new opportunity to obtain high photometric precision with sufficiently continuous coverage and stability to study late-M and L-type very low-mass (VLM) dwarfs, which include the smallest stars and the largest brown dwarfs. Our team has demonstrated the potential of searching for transiting habitable super-Earths among VLM dwarfs with Kepler (Martín et al. 2013). This investigation utilizes Kepler-2 to address the following scientific objectives: (1) Search for transiting exoplanets around VLM primaries, and in particular reaching down to super-Earth sizes in the habitable zones. (2) Monitor rotational periods for VLM dwarfs. (3) Characterize the properties of surface temperature inhomogeneities and their evolution from analysis of Kepler light curves using models that include cool magnetic spots and clouds of dust. (4) Identification of VLM eclipsing binaries. (5) Characterization of the habitable environment around VLM hosts using flare properties. (6) Study of the interdependence of activity, age, rotation and planet detection sensitivity in VLM hosts.

The expected significance is to extend the study of transiting planets, eclipsing binaries and the characterization of photometric variability behaviour to VLM objects, bridging the gap between the low-mass stars and the giant planets. VLM dwarfs straddle the transition from partially convective to fully convective interiors, and the formation of metallic dust grains at the M/L boundary. A detection of just one transiting planet or eclipsing binary in a VLM primary would be very valuable to constrain models of formation, evolution and structure, and the calibration of the relation between spectral type and mass. A null result will be useful to constrain the binary properties and the frequency of planets around VLM objects. Kepler is currently the best observatory to provide a benchmark set of light curves for VLM dwarfs. Light curves of these VLM objects can be used to study the formation and evolution of magnetic cool spots and cloud systems, and to derive rotational periods and flare rates. The Kepler data will have a long lasting impact in this field of research and will feed useful information into planned surveys that target VLM primaries as planet hosts. With our GO4-0030 proposal, we more than doubled the number of VLM targets observed by Kepler, and we enhanced the sample in quarter 16 via a DDT proposal, but few dat were actually taken. We also have experience in revealing VLM objects with the IPHAS survey (Valdivielso et al. 2009). Here, we present a search for VLM dwarfs around the Kepler-2 field using the IPHAS and 2MASS surveys. To select reliable VLM candidates around the Kepler-2 field of view, we applied image quality criteria, color cuts of $i-J>2.0$; $r-i>2.0$; $J-H<1.0$ and $J-K<2.2$, a magnitude limit of $r=19$, and a lower proper motion limit of 10 milli arcseconds (mas) per year. We propose to obtain 30 minute cadence Kepler observations of the following 79 VLM dwarf candidates around the Kepler-2 field 0. Coordinates (J2000) and r-band magnitudes were taken from the IPHAS DR2 survey. The IPHAS coordinates are tied to the 2MASS reference system. For a few of these targets R-band mag. are available from the Palomar Transient Factory archive, and they are about 0.3 mag. brighter than the IPHAS r-band magnitudes.

References Martín, E. L.; Cabrera, J.; Martioli, E.; Solano, E.; Tata, R.. Kepler observations of very low-mass stars, A&A, 555, 108 (2013). Valdivielso, L.; Martín, E. L.; Bouy, H.; Solano, E.; Drew, J. E.; Greimel, R.; Gutiérrez, R.; Unruh, Y. C.; Vink, J. S. An IPHAS-based search for accreting very low-mass objects using VO tools, A&A, 497, 973 (2009).