

THE KEPLER VIEW ON ACTIVITY, BINARITY, HABITABILITY AND WEATHER IN LATE-M AND L DWARFS

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Ultracool dwarfs are numerous in the the solar vicinity. They constitute the low-mass tail of the stellar mass function. The substellar-mass borderline at 75 Jupiter masses is thought to lie at spectral type of M6.5 in the well-known Pleiades cluster. Field dwarfs with spectral type M7 and later include very low-mass stars as well as brown dwarfs. Due to their intrinsic faintness, only 9 very low-mass dwarfs are actually being monitored by the Kepler mission. We propose that 32 additional late-M and L dwarfs are observed during Kepler GO Cycle 4. We have selected these additional dwarfs using multi-wavelength photometric data as well as low-resolution optical spectroscopy for a subset of them. The unique combination of high photometric accuracy and continuous light-curves provided by Kepler can be used to address the following scientific goals: (1) Determination of surface rotational periods for very low-mass stars and brown dwarfs. Stable features in the surface of very low-mass objects, such as long-lived magnetic cool spots or weather patterns such as the red spot on Jupiter, are expected to induce periodic modulation in the light-curves. Periodogram analysis of the Kepler data will yield rotational period for the objects in our sample. (2) Characterize the properties of surface temperature inhomogeneities and their evolution from analysis of continuous light curves of very cool dwarfs. The inhomogeneities in our targets can be due to two kind of features; cool magnetic spots or cloud decks where dust grains are expected to condense. The presence of clouds and their weather-like behaviour can be inferred from the detailed analysis of Kepler light curves. A decrease in the strength of the dominant TiO molecular bands at spectral type M7 and later is a spectroscopic hallmark for the formation of metallic dust condensates in the atmospheres of ultracool dwarfs. Dust grains are thought to condensate into cloud decks that may cover a fraction of the photo-sphere and induce irregular time variable phenomena akin to weather on the atmospheres of planets. (3) Identification of very low-mass eclipsing binaries. So far no eclipsing binaries have been detected with spectral type later than M6. The proposed Kepler observations could detect the first ultracool eclipsing binary, which would be a benchmark for extending the mass-luminosity-spectral type relation to lower masses. The study of eclipsing binaries is much needed to constrain models of very low-mass stars, brown dwarfs and gas giant planets. (4) Characterization of the habitable environment around very low-mass central objects. The habitable regions around late-M and L dwarfs are thought to be tightly wrapped around the central objects. Detailed calculations of the habitable regions around very low-mass stars and brown dwarfs need as input the knowledge about the magnetic activity of these objects. Kepler will provide unprecedented information on the flare frequency and duration of late-M and L dwarfs. The rate of flare events observed in H α emission has been observed to increase toward the late-M spectral types with a peak around M8 and a decrease for later types. However, continuous observations of flare events for timescales of weeks and months in these late spectral type objects are sorely missing. We propose to carry out a homogeneous analysis of our 32 targets together with 9 other very low-mass dwarfs already monitored by Kepler. We propose to develop a model to study the surface thermal inhomogeneities of very low-mass dwarfs using Kepler light curves. A custom-made PSF analysis tool will also be developed to improve the photometric accuracy for faint targets. These software tools will be made available to the entire scientific community.