Determining the Rotational Properties of the T5.5 field dwarf 2MASS J11101001+0116130

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In the collection of white papers that preceded the first call for K2 proposals, Dr. J. Gizis eloquently described [1] how a two-wheel Kepler mission would significantly contribute towards our understanding of "ultracool" (late-M and L), or very low mass, dwarf science - K2's exquisite photometric accuracy combined with long observational baselines would open a unique window on the study of rotation periods (typically over hourly scales), weather, stellar radii, starspots, flare activity, and possibly transiting planets in the habitable zone. The unambiguous detection of long term, stable, rotational period(s) - regardless of origin – also provide an independent means to constrain spectroscopically derived *v* sin *i* estimates, and so viewing geometry. The recent report (Gizis et al., http://arxiv.org/pdf/1310.5940) of a Kepler derived rotational period of 0.37015 days for the faint (*g*=22.4) L1 dwarf W1906+40, stable over 21 months with a peak-to-peak amplitude of 1.4%, underlines the phenomenal capabilities of this observatory.

Recently we have shown the effectiveness of such a long-term observational strategy using ground-based facilities (Harding et al. 2013, ApJ, 779, 101). We obtained high cadence (~ 10 secs exposure) I/R photometry of 6 radio-emitting ultracool dwarfs spanning the M8-L3.5 spectral range over a range of baselines, from 0.03 to 5 years. Previously we had demonstrated that such periodic radio emission has its likely origin via the electron cyclotron maser instability (ECM), necessitating the presence of large scale, stable kG magnetic fields (Hallinan et al. 2008, ApJ, 684, 644). Long-term periodicity in I/R datasets from these dwarfs would be consistent with such stable surface magnetic structures being responsible for the varying modulation, as distinct from less 'coherent' meteorological phenomena. Our data (with a photometric precision at times of ~0.15%) did indeed confirm stable I/R periodicity in 5 dwarfs, consistent with the unambiguous rotational period of each (with a marginal detection in the sixth). For those previously characterized rotationally via a *v* sin *i* estimate, our rotation estimates all implied a corresponding high inclination angle – consistent with the viewing geometry necessary to observe ECM radio emission for such field topologies (Hallinan et al. 2008, ApJ, 684, 644). Indeed, for the M9 dwarf TVLM 513-46546, a stable period of 1.95958±0.00005 hours was determined over a 5 year baseline. These results make a strong case for the existence and maintenance of stable, large-scale kG fields at the sub-stellar boundary - contrary to expectation.

The remarkable recent detection of sporadic, circularly polarized radio flares from the T6.5 dwarf 2MASS J1047+21 unexpectedly suggests the presence of similar strong magnetic field structures in objects as cool as 900K (Route & Wolszczan 2012, ApJL, 747, L22). Whilst meteorological factors are expected to play a significant role in any resulting optical/IR observations, it is reasonable to hypothesize that similar surface structures of a magnetic origin might be expected to introduce a rotationally phased periodic modulation for dwarfs of this spectral class. 2MASS J11101001+0116130 is a nearby (14pc) T5.5 ultracool dwarf for which we have as yet no photometric, radio or *v* sin *i* data available – however it is serendipitously positioned for K2 Campaign 1. SC observations using K2 would provide deep photometric data sufficient to unambiguously identify modulations at << 0.01% level during Campaign 1 over the proposed 75 day baseline, and definitively confirm the presence of periodic rotational modulation(s) - anticipated, given NIRSPEC/KeckII spectroscopy of 9 field T-dwarfs, all yielding *v* sin *i* between 15-40 kms^{-1} (Zapatero Osorio et al. 2006, ApJ, 647, 1405). K2 photometric data would allow us to apply our prior analytical expertise, putting in place a rotational baseline for this dwarf, supporting follow up radio observations and Keck spectroscopy, and so increase our understanding of the magnetic properties of T dwarfs with the first optical light curve for this substellar spectral class.

[1] (http://keplerscience.arc.nasa.gov/docs/WhitePapers/gizis_kepler.pdf)