Ultracool Dwarf Flares in Kepler K2

John E. Gizis (U. Delaware), Peter K. G. Williams (CfA)

Besides coinciding with the hydrogen burning limit, late-M and early L dwarfs are a part of remarkable transition in which the familiar solar/stellar magnetic activity relations break down. Chromosphere emission lines become weak and coronae are usually undetectable but there is ooften strong radio emission (e.g., Berger et al. 2010, ApJ, 709, 332). The objects are rotating rapidly ($P < 10$ hours) with little magnetic braking (Reiner & Basri, 2008, ApJ, 684, 1390). This transition is one of the key puzzles in very-low-mass stars and brown dwarfs. The neutrality of the atmospheres (Mohanty et al., 2002, 571, 469) and a changed dynamo (e.g., Cook et al., arXiv:1310.6758) are often invoked, preventing magnetic reconnection events. Nevertheless, when Kepler observed the nearby L1 dwarf W1906+40 in short cadence mode during Quarter 13, Gizis et al (2013, ApJ, 779, 172) observed 21 white light flares; fortunately, two of these occurred during Gemini spectroscopy (Figure 1) confirming that this early L dwarf is capable of generating flares similar to those on M dwarf flare stars, and as energetic as the most powerful known solar white light flares. Flares may play an important role in the heating of the chromosphere, and would affect “habitable” planets. Because of their proximity, such planets would experience the strongest W1906+40 flare as equivalent to the strongest AD Leo flare modeled in Segura et al. (2010, AstroBio, 10, 751). These are the only white light flares ever detected in any L dwarf. Indirect evidence suggests that W1906+40 is billions of years old (i.e., a star, not a bona fide brown dwarf), suggesting the flare rate may not decay as rapidly with time as in GKM dwarfs. We need an expanded sample to investigate how flares depend on stellar properties, but ground-based monitoring with large telescopes is impractical at the rate of only ~ 1 flares per week even with 24 hour coverage. Our goal is to use the Kepler K2 campaigns to understand the flaring properties of the lowest mass stars and brown dwarfs.

Our Campaign 1 proposal was to observe four ordinary field L0-L1 dwarfs. The Campaigns 2 and 3 fields allow new areas of parameter space to be observed. The Campaign 2 field is rich in known late-M and L dwarf Upper Sco members. These brown dwarfs have the same temperature as field dwarfs, but are much lower surface gravity, age and mass; whether they will be similar to the field objects is completely unknown. We propose to monitor six of them at short cadence to detect flares. Campaign 3 does not include any published nearby L dwarfs in the field of view, but there are three important late-M dwarf targets. LP 759-17 (Gizis et al. 2000; Phan-Bao et al. 2001) is a bright, nearby (~ 25 pc) M6.5 dwarf with strong H alpha emission; we expect a high flare rate just before the sharp magnetic activity decline. 2MASSI J2214506-131959 is bright, nearby (32 pc) M7.5 dwarf (Cruz et al. 2003, AJ, 126, 2421), just warmer than the L dwarf sample. The M7 dwarf 2MASS J22522850-1019106 was studied at high resolution by West & Basri (2009, ApJ, 693, 1283), who found it have no Balmer emission lines and low $v \sin i$; if it does not have a low flare rate that would be another sign of the break-down of solar-type correlations.

It is important to recognize that although the targets are faint compared to traditional Kepler targets, the flares are so hot compared to the photosphere they are detectable. *Flares are too diluted in long cadence observations to be reliably detected, but in short cadence W1906+40 brightened by as much as four times.* Scaling the relative brightness and observed flares of W1906+40 to the targets we expect to detect ten flares per Upper Sco target; the Campaign 3 targets are brighter than so even more should be detectable if the flare rate is similar. We will be able to answer questions such as: Are flare rates correlated with rotation rate, spot properties (both observable by Kepler K2), or quiescent Hα emission? Is the flare rate independent of age? How does the L dwarf flare rate compare to warmer late-M fully convective stars?