

M 35: A K2 Study of Stellar Rotation and Variability

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The inclusion of M 35 (age ~ 150 Myr) in Field 00 presents a unique opportunity for an intensive investigation of stellar rotation and transient phenomena in a sample that is homogeneous in age and chemical composition.

Rotation, specifically, differential rotation combined with outer envelope convection in the late-type stars, is a key parameter in stellar dynamo-field generation that ultimately gives rise to magnetic field-related activity. Understanding the origin and nature of magnetic activity in cool stars is critical because magnetic fields (1) govern angular momentum evolution (through the interaction of field lines and outflowing ionized plasma), (2) modulate the energetic particle and luminous output of cool stars, most noticeably at short wavelengths, and (3) are the origin of “space weather” in the Sun and stars. Space weather can have a significant impact on the environment of the Habitable Zone by creating hazardous conditions for the development of life, such as the destruction of atmospheric ozone due to the impact of energetic protons.

An extensive database on cluster membership already exists for M 35 (Geller et al. 2010; AJ, 139, 1383). Meibom et al. (2009; ApJ, 695, 679) give rotation periods for 441 stars derived from ground-based photometry of the M 35 field as obtained during 2002 — 2003. The addition of *Kepler* observations at the anticipated precisions will enable a comparison with the prior ground-based rotation period measurements in order to detect period changes, indicative of differential rotation. The results will extend the recent work of Reinhold et al. (2013; A&A, 560, A4) on the measurement of differential rotation in the *Kepler* field to a uniform sample of young stars. With anticipated precisions that are at least an order of magnitude better than can be achieved with ground-based photometry, the K2 data will add new rotation period measurements, particularly for stars with relatively lower-amplitude modulation of their light-curves.

In addition to measurements of differential rotation, the continuous monitoring of the field will reveal the range of variability present due to transient phenomena such as exceptionally violent flare outbursts, or ‘superflaring’ (Maehara et al. 2012; Nature, 485, 478), characterized by energies that exceed the strongest solar flares by one to six orders of magnitude! Notsu et al. (2013; ApJ, 771, 127) find that superflare frequency increases with increasing rotation rate to a saturation level. Flare energy appears to show a decline with increasing rotation period though with considerable scatter. The M35 data will enable further investigation of these trends, as seen in the inhomogeneous *Kepler* field, with a stellar sample at a single, young age that is expected to exhibit frequent and energetic flaring. Finally, brightness variations due to granulation patterns at the level of 3 parts per thousand (or less) on timescales of less than 8 hours may be detected. This ‘flicker’ in the stellar light curve is correlated with stellar surface gravity and can enable the determination of surface gravity to better than 25% (Bastien et al. 2013; Nature, 500, 427).

We selected targets from Geller et al. that have cluster membership probabilities $> 50\%$ and apparent brightness of $12 < V < 17$ mag. Note that at a distance modulus of $+10.39$, a “solar twin” in M 35 has a V-mag of about 15.2. We also have added 263 stars with measured rotation periods from Meibom et al. with apparent brightness of $12 < V < 17$ mag (of which 124 are in common with Geller et al.). The total number of targets requested is 482. The target table has been formatted as requested with R.A. and DEC given in J2000.0 in decimal degrees (columns 1 and 2) and apparent V magnitude (column 3).