ROTATIONAL PROPERTIES AND EVOLUTION OF YOUNG STARS IN UPPER SCO: K2–FIELD02

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Scientific Goals: Measure the rotation periods, differential rotation patterns, and the distribution, migration, and growth/decay of large dark photospheric starspot groups for 5 Myr old stars and brown dwarfs in the Upper Sco association and investigate the rotational evolution of fully-convective, low-mass, pre-main-sequence stars as their disks dissipate. We shall study how the rotational properties depend on stellar mass and evolutionary state.

Scientific Background: Rapidly rotating stars have strong surface magnetic fields that produce large photospheric starspots (readily observable by K2). Young stars rotate quickly because they have not yet dissipated their primordial angular momentum and spin-up significantly move towards the main sequence. Initially, angular momentum loss is inhibited by strong locking between the still-accreting star and its circumstellar disk. The rotational history of associations of young stars are therefore closely tied to the processes of disk evolution and dissipation. The Upper Sco portion of the Sco OB2 association (Preibisch & Mamajek 2008, Handbook of Star Forming Regions, Vol. II) is the premier region in which to study this rotational evolution, because its age of 5 Myr samples the most important time in this evolution and its distance of only 145 pc provides many bright targets spread diffusely across the sky, reducing the crowding problem of more distant clusters. At 5 Myrs, roughly 20% of the K-M stars still have their primordial disks, while almost all the G stars have lost their disks. Many faint late-M members are known that will become brown dwarfs; although at this age the distinction between stars and brown dwarfs is less important since none of the objects are yet burning hydrogen. How such fully-convective stars generate and maintain strong magnetic fields is poorly understood. Modeling the distribution of their starspots using K2 photometry will provide important clues regarding the generation of stellar magnetic fields via dynamo processes.

K2 Target Selection: 322 Upper Sco members are proposed as K2 targets. Their magnitudes, m_{Kep} = 9-17, are well suited to standard K2 observing methods. The first 56 targets are from X-ray surveys and are bright, well-studied stars. The remainder are typically fainter, later spectral type objects, few of which have known rotation periods. Masses range from a solar mass down to tens of Jupiter masses. Stars were selected from various surveys for Upper Sco members, including X-ray surveys by Einstein (Walter, Vrba, Mathieu, Brown, & Myers 1994, AJ, 107, 692) and ROSAT (Preibisch & Zinnecker 1999, AJ, 117, 2381) and optical surveys by Preibisch et al. (2002, AJ 124, 404), Lodieu et al. (2007, MNRAS, 374, 372), Slesnick et al. (2008, ApJ, 688, 377), and Lodieu et al. (2013, MNRAS, 435, 2474). Only targets falling on active K2 CCDs were selected using K2FOV. Targets affected by strong source confusion or crowding were excluded – with criteria of no brighter star within 20 arcseconds and no star having m_{Kep} within 1 magnitude within 10 arcseconds. The star density is high in Field2 and source confusion problems are ubiquitous but, by careful choices during our target selection, these problems should be minimized for the sample proposed here.

Description of the Observations: Long (30 min) cadence observations are requested for all the targets. A ~75 day interval is well matched to the expected rotation periods, which range from 0.5 days to a week for the Upper Sco stars with previously measured periods.

Supporting Observations: Simultaneous multicolor optical photometry will be sought using APO (New Mexico) and SMARTS (Chile) telescopes.

Data Analysis: Our current *Kepler* data analysis and starspot modeling tools should be directly applicable to these K2 data. Variability amplitudes are typically a few %, so are well within the K2 capabilities. A suitable investigative team is available from our on-going *Kepler* GO collaboration.