A K2 Study of Young Stars in Upper Scorpius: Disk Effects, Stellar Activity, and Planets at 3-5 Myr

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Young Star Variability. Although young pre-main sequence stars are well-established as variables, the identification and quantification of the variability types, amplitudes, and timescales has undergone a quiet revolution over the past several years. In Cody et al. and Stauffer et al. (2014, AJ, 147, 82 and 83), we recently published by far the highest quality lightcurves of young stellar objects in terms of S/N, cadence, wavelength coverage, and continuous duration. For a sample of objects with disks in the young cluster NGC 2264 (<1 to a few Myr old) we are able to study their photometric fluctuations in exquisite detail and identify the following broad categories of variability, each of which can be more finely divided into sub-categories:

- flux dips due to dust that passes through our line of sight on the stellar rotation period, and is either entrained in the accretion flows between the inner disk and stellar photospheres or located in warps in the innermost disk regions.
- accretion blips due to unsteady mass transfer from disks to stars, signifying either variable flow along or variable penetration of the roughly dipolar magnetosphere.
- periodic modulation due to temperature inhomogeneities (cool/hot spots) rotating with the photosphere.
- flares due to coronal-like magnetic activity.

Upper Sco. The K2 "Field 2" pointing encompasses the Upper Sco region of recent star formation (3-5 or possibly 10 Myr old). In the time span between the age of NGC 2264 and the age of Upper Sco, the stars have contracted by a mass-dependent factor of 50% to 250%, the mass accretion rates have declined producing more quiet photospheric regions, and the circumstellar disks have evolved with most accretion disks dissipated such that giant planet formation is in the final stages, and debris disks, a signature of planets, have begun to form around the earlier-type stars.

The Sample. We propose to obtain lightcurves for a sample of ∼75 stars in Upper Sco that: are known spectroscopic members, have masses $> 0.1 M_{\odot}$, have mid-infrared evidence for disks within 1 AU, and span both primordial (later type stars) and debris (earlier type stars) disk systems. The sample is identical to that currently being observed with ALMA by Carpenter, and thus we will have excellent results on disk mass, size, and orientation to go along with existing SED information and with which to correlate the variability properties. Magnitude ranges from EPIC are 10-15.5^m for the K/M young disk stars and 7-10^m for the B/A/F debris disk stars.

Science Goals. With the lightcurves, we aim to: 1) determine stellar rotation periods, which are also a fundamental time scale in the inner disk; 2) assess and categorize disk-related variability vs disk structure parameters from ALMA; 3) search for eclipses due to binary stellar, brown dwarf, or the youngest *planet* companions.

The Team. We have significant expertise in ground-/space-based lightcurve processing and analysis relevant to K2 data. Collectively, we have (co-)authored 26 unique refereed papers on young star variability over the past 18 years.