Planets Around Likely Young Stars in Upper Sco + Rho Oph

Adam L. Kraus, Kevin R. Covey, Aaron Rizzuto, Michael Ireland, Ann Marie Cody

K2's Field 2 provides a unique opportunity to study planet formation from the initial stages of embryo growth (<1 Myr, in Ophiuchus) to the final stages of planet assembly (~10 Myr, in Upper Sco). The ages of these clusters bracket the dissipation timescale of circumstellar disks, so a differential measure of the planetary frequency in both clusters will provide a strong constraint on the timescales and mechanisms of planet formation and migration. Furthermore, measurements of the temperatures and radii of these young planets will provide new tests for models of exoplanet interiors, atmospheres, and evolutionary paths. Finally, K2 light curves also will identify new pre-main sequence eclipsing binaries for testing evolutionary models, and calibrate the age dependence of critical stellar properties such as rotation, convection, and star spots. Field 2 provides the only access to a significant number of targets in this critical age range, making Upper Sco and Rho Oph an essential complement to the older targets in all K2 fields.

We propose that K2 observe 759 likely members of Upper Sco and Rho Oph that we have identified from color-magnitude and proper motion diagrams. Our companion proposal (PI Covey) features 657 targets that are spectroscopically confirmed members of these young clusters (with unambiguous indicators of youth), and hence are the highest priority targets. Due to the clusters' size, however, the spectroscopic membership of these populations remains incomplete, so we have performed a new search for high-confidence candidates that should complete the full census of both clusters to 0.3 M_{sun}. We will acquire spectra for the vast majority of candidates in 2014, using already allocated telescope time (AAT/HERMES multi-object spectrograph, ANU 2.3m, McDonald 2.7m).

Our selection procedures are based on the highly successful methodology that we described in Kraus & Hillenbrand (2007) and Kraus et al. (2014), studies of the Praesepe and Coma Ber open clusters and the Tucana-Horologium moving group. We used data from the 2MASS, USNO-B1.0, and UCAC4 all-sky surveys to select new candidate Upper Sco and Rho Oph members. We adopt proper motions for bright stars from UCAC4, and use the multi-epoch astrometry in 2MASS and USNO-B to calculate proper motions for fainter stars that are twice as precise as the original USNO-B values. We identify astrometric candidate members by requiring proper motions consistent with the known space velocity of the target population, and use the magnitude of that proper motion to estimate a hypothetical kinematic distance d_{kin} (which should be ~140 pc for both clusters). Constructing 8-band SEDs from 2MASS and USNO-B photometry, we estimate each candidate's spectral type and hypothetical spectrophotometric distance d_{phot} (assuming it lies on the main sequence). Using both d_{kin} and d_{phot}, we can select likely pre-main sequence stars that fall above the main sequence and on the cluster sequence. Finally, we eliminate a) known non-members reported in the literature, b) giants identified via conservative (J-K,K-W3) color-color cuts, and c) blends identified via visual inspection of 2MASS+DSS.

Based on our recovery rate for spectroscopically confirmed members, we estimate that our sample of newly identified candidates is >80% complete for spectral types A5-M5, spanning the bright to faint limits of useful K2 observations. Candidate counts in off-cluster flanking fields of equal galactic latitude and extinction imply that >1/2 of our proposed targets (which do NOT include the known members from Covey's proposal) are bona fide young stars. Most of the non-members should be foreground K-M dwarfs (with actual distances ~50-100 pc), and hence will be still be valuable targets for field exoplanet studies.

References: Kraus & Hillenbrand 2007, ApJ, 134, 2340; Kraus et al. 2014, AJ, 147, 146.