K2 Monitoring of Confirmed Members of Upper Sco + Rho Oph

Kevin R. Covey, Adam L. Kraus, 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 two clusters are well matched to the dissipation timescale of circumstellar disks, such that 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. Measurements of the temperatures and, more critically, radii (which can only be measured for transiting systems) of these young planets will provide new tests for models of exoplanets' interiors, atmospheres, and evolutionary paths. K2 light curves of young stars that lack transiting planets will also identify new eclipsing binaries for testing evolutionary models, and calibrate the age dependence of critical stellar properties such as rotation, convection, and star spots. Among the stellar populations covered by the proposed K2 field plan, only Ophiuchus and Upper Sco in Field 2 provide access to a significant number of stars and planetary systems in this critical age range, making these targets an essential complement to the older field stars and planetary systems in every other K2 field.

We propose that K2 observe all 657 optically visible (Kp < 16), previously confirmed members of the Upper Sco and Rho Oph clusters that fall on K2 silicon; our companion proposal (PI Kraus) highlights an additional 759 candidate Upper Sco & Rho Oph members that will maximize the completeness, and thus the science return, of K2's Field 2 observations. From Howard (2013), we know that the frequencies of planets with orbital periods <25 days range from ~7% for R~2-3 R_{Earth}, to ~1% for R~8-16 R_{Earth}. For typical transit probabilities of ~10%, the detection rate for such systems will be solidly within the sub-percent regime, such that **we need to monitor ~1000+ candidate young stars (ie, the 657 known members that we propose here, and the several hundred new members in our companion proposal's sample) to ensure that we detect the ~6 mini-Neptunes, ~3 Neptunes, and ~1-2 Jupiters expected if planets are as ubiquitous in young clusters as in the field.**

Our catalog of confirmed members of Upper Sco includes sources from the literature with radial velocities or parallaxes and proper motions consistent with cluster membership, or in the absence of such measurements, clear spectroscopic indicators consistent with an age of <15 Myrs (e.g., robust Halpha emission, lithium absorption, low surface gravity, etc.). To confirm membership in Rho Oph, we require either similar spectroscopic evidence as in Upper Sco, or clear evidence of a near/mid-IR excess indicative of a warm inner circumstellar disk. Studies from which these confirmed members are drawn are listed below; from these sources we identified 2091 confirmed members of Rho Oph and the full Sco-Cen stellar population. Restricting the sample to objects which are expected to fall on K2 silicon reduces the sample to 797 members; of these, 657 have EPIC counterparts with expected Kepler magnitudes between 5.5 - 16, the range for which K2 is expected to deliver light curves with 100-500 ppm precision. These data will reveal transits by young gas/ice giants, eclipses by stellar companions, and photometric modulation indicating precise stellar rotation periods and spot properties.

References: Aarnio et al. 2008; Alcala et al. 2002; Alves de Oliveira 2010; Ardila et al. 2000; Bouvier & Appenzeller 1992; Chen et al. 2011; Doppmann et al 2003; Elias et al. 1978; Erikson et al. 2011; Greene & Lada 2002; Gregorio-Hetern et al. 1992; Herbig & Bell 1988; Howard et al. 2013; Kraus & Hillenbrand 2007, 2009; Krautter et al. 1996, 1997; Kunkel et al. 1999; Lodieu et al. 2006, 2008, 2011a; Luhman & Rieke 1999; Luhman & Mamajek 2012; Mamajek et al. 2002; Mamajek 2005;Martin et al. 1998, 2000, 2004; Melis et al. 2012; Meyer et al. 1993; Natta et al. 2002; Preibisch et al. 1998, 2002,; Preibisch & Mamajek 2008; Slesnick et al. 2006, 2008; Torres et al. 1995; Viera et al. 2003; Walter et al. 1994; Wichmann et al. 1997, 1999; Wilking et al. 2005