A SIGNIFICANT POPULATION OF CANDIDATE NEW MEMBERS OF THE ρ OPHIUCHI CLUSTER

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ABSTRACT

We present a general method for identifying the pre-main-sequence population of any star-forming region, unbiased with respect to the presence or absence of disks. We have applied this technique to a new, deep, wide-field, near-infrared imaging survey of the ρ Ophiuchi cloud core to search for candidate low mass members. In conjunction with published *Spitzer* IRAC photometry, and least squares fits of model spectra (COND, DUSTY, NextGen, and blackbody) to the observed spectral energy distributions, we have identified 948 candidate cloud members within our 90% completeness limits of J = 20.0, H = 20.0, and K_s = 18.5. This population represents a factor of ~4 increase in the number of known young stellar objects (YSOs) in the ρ Ophiuchi cloud. A large fraction of the candidate cluster members (81% ± 3%) exhibit infrared excess emission consistent with the presence of disks, thus strengthening the possibility of their being *bona fide* cloud members. Spectroscopic follow-up will confirm the nature of individual objects, better constrain their parameters, and allow an initial mass function to be derived.

J, H, and Ks Observations

- IRIS2 on the Anglo-Australian 4.0 meter telescope
- IRIS2 plate scale 0.45 arcsec/pixel
- Filters used: IRIS2 J (1.245 μm), K_s (2.144 μm). H = CH_4s (1.570 μm) + CH_4l (1.690 μm)
- Total on-source integration time at each position was 5 minutes for the J and Ks filters, and 16 minutes for H-band
- 90% completeness limits: J = 20.0, H = 20.0, K_s = 18.5
- Mass sensitivity: 90% complete to ~1.5 M_{Jup} for 1 Myr age and photospheric temperature of ~1100K at 124 pc for A_V = 0 ; falls to 2.0, 4.0, and 8.5, and 10 M_{Jup} for A_V = 5, 10, 15, and 20, respectively.

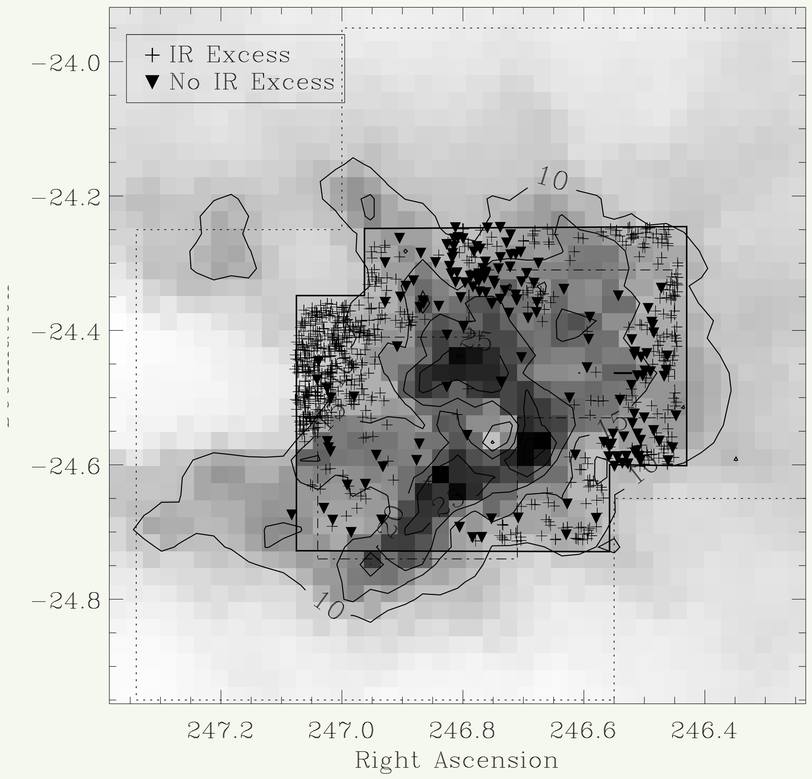

FIG. 1.— Plot of the spatial distribution of our 948 candidate ρ Ophiuchi members (crosses = infrared excess sources, filled triangles = non-excess sources) superposed on the extinction map that was derived from the 2MASS catalog as part of the COMPLETE project (Ridge et al. 2006, AJ, 131, 2921; Lombardi et al. 2008, A&A, 489, 143). A_V contours are plotted and labelled at A_V = 10, 15, 20, and 25. Our 920 arcmin^2 survey area is indicated by the solid outline. The survey areas of Geers et al. (2011, ApJ, 726, 23) and Alves de Oliveira et al. (2010, A&A, 515, 75) are indicated by the dot-dashed and dotted outlines, respectively.

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Results

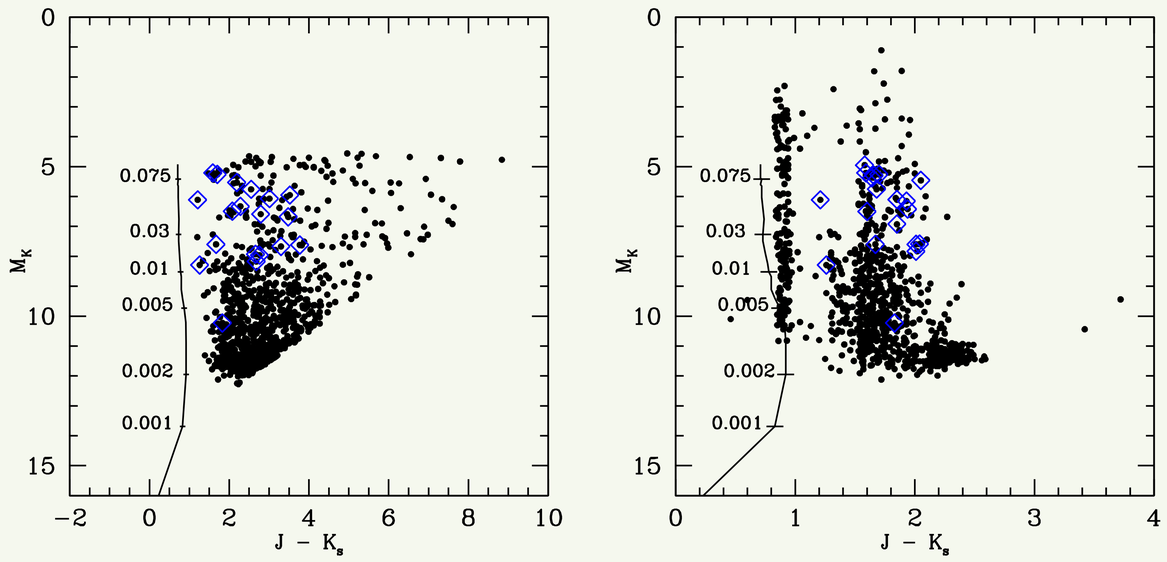

Fig. 2.— Plot of our 948 new candidate cloud members in the "raw" (left panel) and extinction-corrected (right panel) Ks vs. J - Ks color-magnitude diagram (CMD).
The majority (81%) of these exhibit near-infrared excess emission, and are referred to as "excess" sources. An extinction estimate was made for each of the "excess" (disk-bearing) sources by de-reddening to the classical T-Tauri star locus (Meyer et al. 1997 AJ 114 288). Extinction estimates for the remaining, "non-excess" (bare photosphere) sources were made by de-reddening to the main-sequence locus (Bessell & Brett 1988 PASP 100 1134). Sources plotted as blue diamonds are spectroscopically confirmed substellar mass objects with disks. The locus of the 1 MYr DUSTY model is plotted in each panel, with tickmarks indicating various model masses in solar mass units.
Note the dramatic appearance of the "non-excess" sources in the extinction-corrected CMD paralleling the DUSTY model, and the dramatic gap between these and the disk sources.

Substellar-Planetary Mass IMF

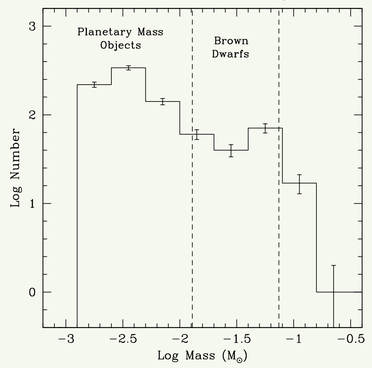

Fig. 3.— Plot of substellar to planetary mass IMF, assuming all 948 new candidates to be cloud members. De-reddened J magnitudes were used to estimate absolute J magnitudes for all sources, since this band is least affected by disk emission. 1 MYr COND or DUSTY models were then used to infer masses from absolute J magnitudes. The 57 objects in our survey with M>0.1 M_{solar} are excluded from this plot. Note the dramatic rise in number of sources across the planetary mass boundary. Follow-up spectroscopy is in progress.

Reference

Barsony, M., Haisch, K.E. Jr., Marsh, K.A., & C. McCarthy 2012 ApJ 751 22
http://arxiv.org/abs/1206.4552