A *SPITZER* SURVEY OF PROTOSTARS AND DISKS IN EMBEDDED CLUSTERS.

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There is a broad continuum of star forming environments, from low density, low mass groups in the Taurus complex to rich clusters centered around high mass stars, such as the Orion Nebula cluster. These groups vary tremendously in their intrinsic properties, but one common emerging picture is that the cluster formation process, from the onset of cloud fragmentation and star formation to the rapid dispersal of the natal molecular cloud by stellar feedback, is highly dynamic and very inefficient. Most stars form in clusters; thus to improve our understanding of star formation, several questions must be answered. How do the properties of the natal molecular cloud dictate the properties of the emerging clusters? How does environment affect star formation? Do stars in dense clusters form differently than those in relative isolation? Is planet formation affected by environment as well?

The *Spitzer* Young Stellar Cluster Survey has been designed to explore the process of star formation across a wide range of environments in an effort to answer these questions. We have selected over thirty young (<3 Myr) stellar clusters and groups within 1 kpc of the Sun that are still associated with their natal molecular clouds. These clusters span two orders of magnitude in molecular gas mass, four orders of magnitude in far-IR luminosity, and a factor of thirty in estimated numbers of pre-main sequence members. We present here results for six clusters from the Survey sample that have 50 or more known members in order to analyzes stellar distribution structure and corresponding dust and gas density structure. Each cluster has been observed at infrared (1-8 μm) and submillimeter (850 μm) or millimeter (^{13}CO, C^{18}O) wavelengths to characterize its young stellar object (YSO) membership and natal molecular cloud, respectively.

We employ a new YSO identification and classification method using *H* (1.6 μm), *K* (2.2 μm), 3.6 μm, and 4.5 μm photometry to confidently detect and separate Class I protostars, Class II stars with disks, and diskless stars (Class III pre-main sequence stars as well as field stars) down to the Hydrogen-Burning Limit for reddening in excess of A_V = 30. This work demonstrates the power of combining *Spitzer* Infrared Array Camera (IRAC) data with ground-based near-infrared data to identify the young stellar objects with protostellar envelopes or circumstellar disks in a cluster. We use the presence of circumstellar matter as a cluster membership criterion, isolating a population of members that trace distributed star formation sites undetected by statistical analysis of field star contamination.

The results are that three of the clusters (GGD 12-15, IRAS 20050+2720, and Monoceros~R2) are elongated, with the distributions of YSOs aligned with high column density molecular gas. The remaining clusters (NGC 7129, AFGL 490, and Cepheus A) are more circularly symmetric, with the YSOs concentrated toward local minima in the molecular cloud column density. The elongated clusters tend to have higher average and peak number densities and a signficant number of Class I protostars. Furthermore, the Class I protostars in these clusters form distinct clumps and linear structures that trace the densest gas, while the distributions of Class II stars with disks is more diffuse, though still elongated and representative of the cloud morphology. In contrast, the symmetric clusters have much lower number densities, and they have far fewer Class I protostars, suggesting a more evolved YSO population. Thus we argue that dynamical evolution may explain the current lack of structure in these clusters.

These results suggest a picture in which the clusters form from the fragmentation of filamentary structures in molecular clouds, with the cluster taking on the same asymmetric character as their parental clouds. The mass is dominated by the molecular gas, and this may maintain the high stellar densities and the elongated cluster structure. Stellar feedback from winds, outflows and radiation, however, act to disperse the gas mass which binds the clusters. The resulting expansion of the clusters erases the original elongated structure and lowers stellar densities. During this expansion phase, pockets of dense molecular gas may persist and continue to form stars.

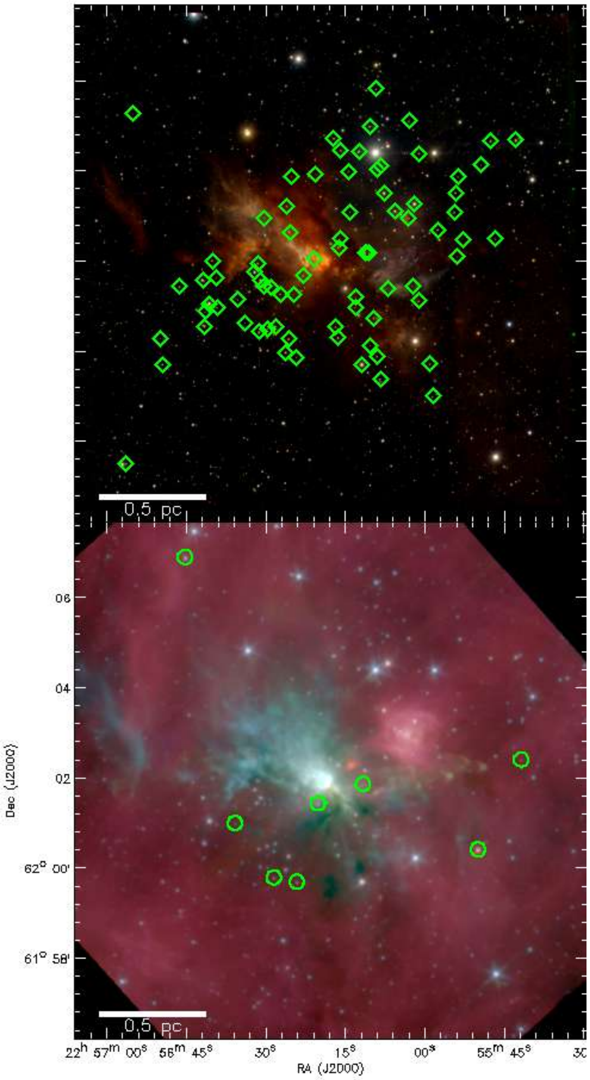

Fig. 1: Color composite images of Cepheus A. The top image is constructed from ground-based JHK (blue, green, and red) observations, and the overplotted green diamonds mark the locations of all identified Class II stars with disks. The bottom image is constructed from *Spitzer*/IRAC 3.6, 4.5 and 8.0 μm (blue, green, and red) observations, and the overplotted green circles mark the locations of all identified Class I protostars. Note the overall lack of Class I protostars and the diffuse, circularly symmetric nature of the distributions of Class II stars with disks.

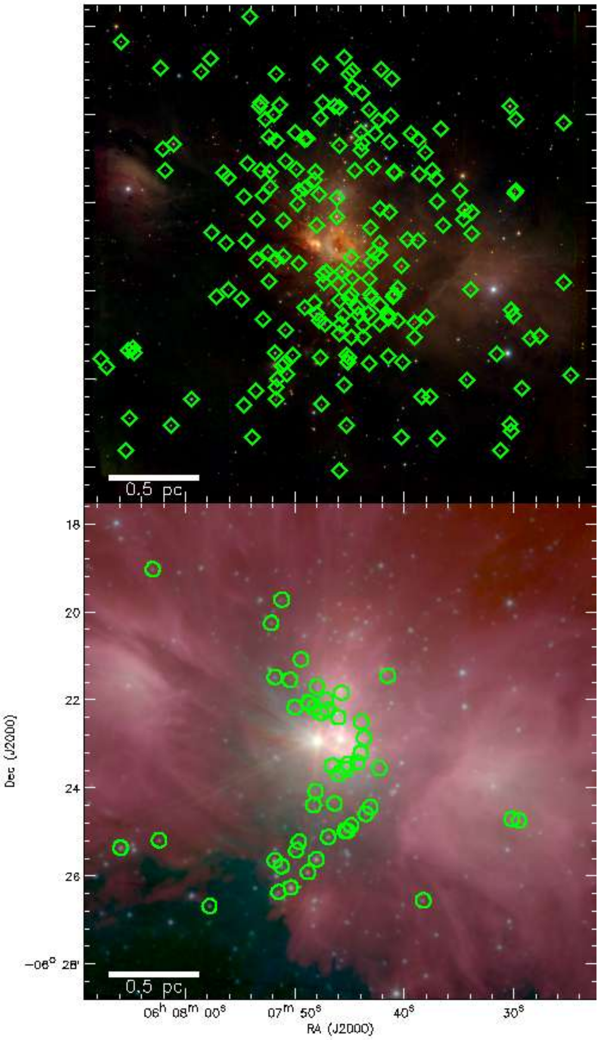

Fig. 2: Color composite images of Monoceros R2. The top image is constructed from ground-based JHK (blue, green, and red) observations, and the overplotted green diamonds mark the locations of all identified Class II stars with disks. The bottom image is constructed from *Spitzer*/IRAC 3.6, 4.5 and 8.0 μm (blue, green, and red) observations, and the overplotted green circles mark the locations of all identified Class I protostars. Note the extended north-south linear structure in the distribution of Class I protostars and the dense distribution of Class II stars with disks, also elongated north-south.