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Near-Infrared Observations of IRAS Sources In and Near Dense Cores

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We report 0.4 to 20 μ m photometry of 27 IRAS point sources associated with dense cores in nearby dark clouds.

It is found that these objects have a bimodal distribution of spectral slopes. The objects in the group with steep spectral slopes (s= $\frac{log(S_\nu(25\mu m)/S_\nu(2.2\mu m))}{log(25/2.2)}$ $\sim$ 2) are typically within one half power radius of the core peak and are not visible on the POSS. The remainder of the objects are typically further from their cores, are optically visible and have shallow spectral slopes (s $\sim$ 0.6). Most of the sources in this group which have been previously identified are T Tauri stars. Both the groups of objects have essentially the same luminosity function with median luminosity of 1 - 2 $L_\odot$, which is similiar to the luminosity function for T Tauri stars.

The near-infrared (J,H,K,L) colors of the objects have been used to estimate the visual extinction to the stars. This indicates that the typical steep spectrum source has extinction A_v $\sim$ 30 magnitudes, which is larger by a factor of 3 to 4 than a uniform core can provide, thus the density must rise steeply in the vicinity of the star. For those objects where optical estimates of the extinction are available the optical estimates are typically smaller than our IR estimates by a factor of 1.6. For multiple scattering by grains that scatter primarily in the forward direction, this implies a grain albedo of $\sim$0.4 at V, consistent with theoretical predictions for bare grains.

Using this derived extinction, the FIR emission from a spherical shell with an inverse power law density which contributes the correct amount of extinction has been modelled. It is shown that to be consistent with both the observations of the density of the core at a scale of 1.5×10^{17}cm and the extinction derived from the near-IR colors there must be a circumstellar 'hole' of radius 10-100 A.U. for all density laws with exponents greater than 1.2.

It is also shown that a component in addition to the star and circumstellar shell is necessary to match the observed spectrum of steep spectrum sources. The additional component must contribute about 1/3 of the total luminosity of the source and have a sub-stellar temperature. It is suggested that the most likely source of this missing luminosity is a circumstellar disk.

From the number of sources observed in Taurus-Auriga and the number of known optically visible T Tauri stars in the same region, the time a young star remains in the highly obscured stage represented by our steep spectrum sources is estimated. This time is $3 - 8 \times 10^4$ years, which is shorter than the free-fall time for a typical dense core and is comparable to the dynamical time estimated for the CO outflows associated with many of the sources.