PROBING THE INNER 200 AU OF LOW-MASS PROTOSTARS WITH THE SUBMILLIMETER ARRAY.

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With the Submillimeter Array a new window has opened to study the innermost (∼100 AU), warm and dense regions of the envelopes and disks around deeply embedded protostars. The advantages of the SMA for studying the physics and chemistry of deeply embedded protostars are:

- **Submillimeter wavelengths:** Studies based on observations of lower excitation lines Studies based on lower excitation lines do not probe deep inside the envelope since these lines are sensitive to the chemistry in the outer cold regions and become optically thick. In the 325-365 GHz window a wealth of molecular transitions constrain the chemistry in the dense ($\sim 10^7 - 10^8$ cm^{-3}) and warm ($\sim$ 100 K) material in the envelope. Likewise since the dust continuum flux scales with frequency as ν^2 or steeper, submillimeter observations are well suited for probing the dust in protostellar disks.

- **High angular resolution:** The innermost regions of the envelopes where the temperature increases above 100 K are heavily diluted in a single-dish beam ($< 2''$ size compared to typical single-dish beam sizes of 10-20$''$). Interpretation of the line emission from these regions relies on extrapolation of the density and temperature distribution from observations on larger scales. Typical SMA observations resolve the emission down to these scales and make it possible to disentangle the emission from the envelope and circumstellar disk.

All in all, studies of the continuum and line emission with the SMA provide a unique possibility to probe the warm and dense gas and dust of protostellar envelopes on small scales. Moreover, the data provide constraints on the physical and chemical properties of disks in these deeply embedded stages. We have undertaken a survey of a large sample of deeply embedded protostars with the Submillimeter Array, "Protostellar Submillimeter Array Campaign (PROSAC)". A sample of 9 sources has been observed systematically in a wide range of lines at 218-355 GHz. The sources were selected from a large single dish survey by Jørgensen et al. (2002), with the outer envelope on scales of 500-5000 AU constrained by detailed line and continuum radiative transfer models.

As an example of the potential of the program, Fig. 1 shows the detection of continuum and high excitation transitions toward the class 0 object, NGC 1333-IRAS2A. The continuum is clearly resolved: in addition to the extended envelope, also observed with single-dish telescopes, a compact but resolved disk structure is seen. The size of this disk is about 300 AU. Such a disk structure would suggest that circumstellar disks rapidly build up in the protostellar stages and their presence implies a cavity exists in the envelope with a size determined by the rotation of the protostellar core.

Cavities of the size of circumstellar disks are seen in other objects (see Jørgensen et al. 2005b and poster by Schöier et al.). An important implication is that the temperature in the inner envelope does not exceed 70–90 K. Given the disk mass, ∼a few×0.01-0.1 $M_\odot$, inferred from the continuum emission, this component will provide a significant contribution to the observed emission in the interferometer beam and will in fact dominate the column density of a potential hot core. A likely explanation for the observed emission from the complex organic molecules is that these species reside in this circumstellar disk.

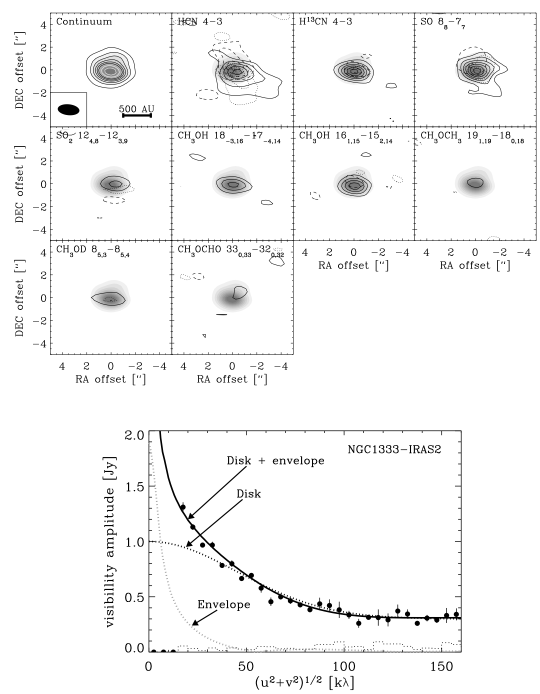

Figure 1: NGC 1333-IRAS2A observed with the SMA. *Top:* detection of high excitation molecular line emission. The contours are given in steps of 3σ. *Bottom:* The presence of the circumstellar disk inferred from 850 μm continuum observations by a combination of an extended envelope and a 300 AU circumstellar disk. From Jørgensen et al. (2005a).

References: [1] Jørgensen, J. K., Bourke, T. L., Myers, P. C., Schöier, F. L., van Dishoeck, E. F., & Wilner, D. J. *2005a, ApJ, in press. (astro-ph/0506671)*. [2] Jørgensen, J. K., Lahuis, F., Schöier, F. L., van Dishoeck, E. F., et al. *2005b, ApJL, in press. (astro-ph/0508210)*. [3] Jørgensen, J. K., Schöier, F. L., & van Dishoeck, E. F. *2002, A&A, 389, 908*