Hot Star Workshop III: The Earliest Phases of Massive Star Birth
*ASP Conference Series, Vol. ***, 2002*
P. A. Crowther

A CS J= $5 \rightarrow 4$ Mapping Survey Towards High Mass Star Forming Cores Associated with H_2O Masers

Y. L. Shirley, N. J. Evans II, K. E. Mueller, C. Knez, & D. T. Jaffe

Department of Astronomy, The University of Texas at Austin, Austin, Texas 78712–1083

Abstract. In this survey we have systematically mapped 63 cloud cores in the CS J= $5 \rightarrow 4$ line towards a sample of high mass star forming cores with water masers (Plume et al. 1992, Plume et al. 1997) using the CSO. From the CS spectra and maps we determine cloud core sizes, virial masses, a mass spectrum, and a size-linewidth relationship.

1. Introduction

Sixty-three high mass star forming cores selected from the study of Plume et al. (1997; $T_R^* > 1$K) were mapped in CS J= $5 \rightarrow 4$ at the CSO between September 1996 and July 1999. Nearly all of the cores observed lie in the first and second galactic quadrants. The cores were mapped using the on-the-fly technique with a square grid in RA-DEC coordinates oversampled at $10''$ resolution. The maps were extended until the CS emission was negligible ($\pm 50''$ for the average map).

2. Discussion

The size of each core was determined by deconvolving the telescope main beam FWHM from the observed FWHM of the core. Fifty-seven cores had clearly defined FWHM with an average size of 0.38 ± 0.28 pc. Six cores contained multiple peaks within the core FWHM and were not included in the average. Thirty-three cores had deconvolved sizes that are larger than the CSO beamsize indicating that the majority of cores were resolved. The distribution of core sizes (Figure 1a) is peaked about the mean; however, we are biased against small cores sizes due to the resolution of the CSO beam and the large distance of high mass star forming regions ($< D >= 5.5 \pm 3.7$ kpc).

A size-linewidth relationship can be determined from Gaussian fits to the linewidth of the convolved map of the source ($< \Delta v >= 5.78 \pm 2.74$ km/s). The size-linewidth relationship shows a weak correlation ($r_{corr} = 0.54$; Figure 1b) with a least squares fit of $\Delta v \sim R^{0.76 \pm 0.07}$ and robust estimation fit of $\Delta v \sim R^{0.34}$. All of the linewidths are significantly higher than the size-linewidth relationship determined by Caselli & Myers (1995) for massive cores in Orion indicating that the average high mass star forming core linewidth associated with a water maser is very turbulent.

The mean virial mass of a core was calculated using the CS linewidth and core FWHM size to be 4550 ± 1380 $M_\odot$ which translates into an average surface

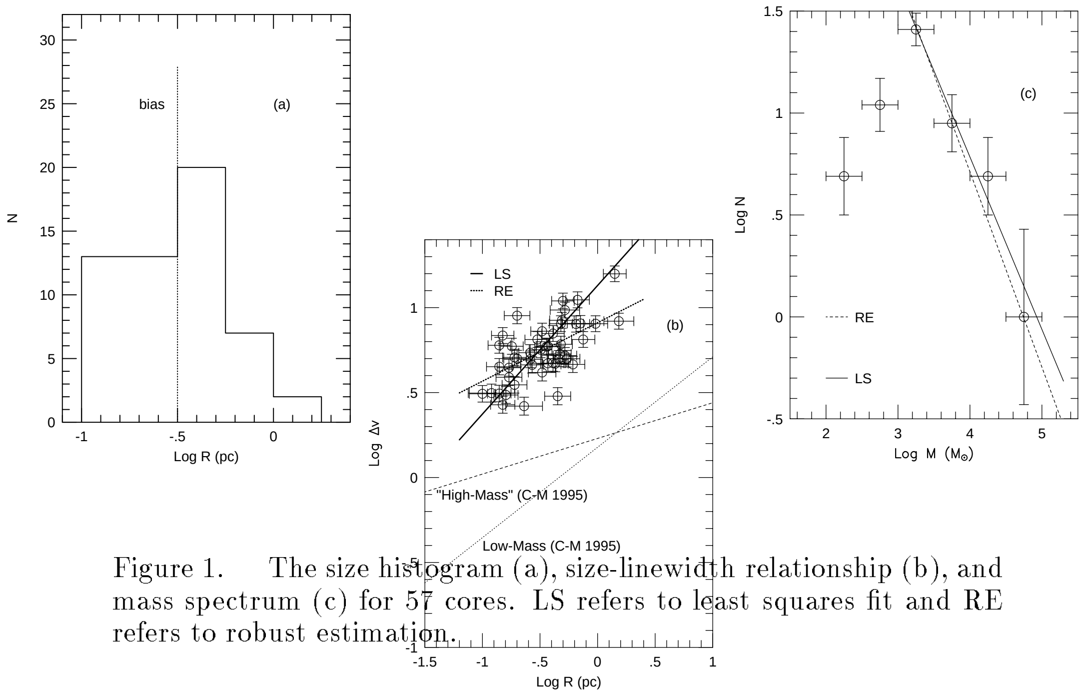

Figure 1. The size histogram (a), size-linewidth relationship (b), and mass spectrum (c) for 57 cores. LS refers to least squares fit and RE refers to robust estimation.

density of 1.68 g cm^{-2}. The corresponding mass spectrum is well fit by a power law (Figure 1c), $dN/dM \sim M^{-1.8}$ to $M^{-2.0}$ using least squares and robust estimation. Since we are biased against detecting small core masses ($M < 1000$ $M_{\odot}$), the power laws fit to the mass spectrum is restricted to masses larger than 10^3 solar masses. The virial mass was derived assuming a constant density envelope and that the CS line was optically thin. Preliminary results from dust modeling of 350 μm emission ($n \sim r^{-p}$, $<p> = 1.73 \pm 0.35$ for 28 cores; Mueller et al. these proceedings) and $C^{34}S$ observations ($\Delta v(\mathrm{CS})/\Delta v(\mathrm{C^{34}S}) = 1.3 \pm 0.3$ for 10 cores) indicate that the average virial mass and surface density are reduced by a factor of 0.43 when these effects are included.

This CS mapping survey provides a more unbiased look at the statistical properties of high mass star forming cores associated with water masers. Combined with studies of dust continuum emission (Mueller et al. these proceedings) and Monte Carlo modeling of multiple CS transitions (Knez et. al. these proceedings), a more definitive picture of the density and temperature structure of the envelopes of high mass star forming cores is emerging.

References

Caselli, P., & Myers, P. C. 1995, ApJ, 446, 665

Plume R., Jaffe, D. T., Evans, N. J. E. 1992, ApJS, 78, 505

Plume R., Jaffe, D. T., Evans, N. J. E., Martin-Pintado, J., & Gomez-Gonzalez, J. 1997, ApJ, 476, 730