

^{13}CO , C^{18}O and CS Observation towards Massive Dense Cores

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Primary Motivation

- To search for high-density cores which are just undergoing or before the phase of star formation

Search for early stage of massive star formation regions

- High luminosity
- High column density
- Outflow
- Without cm emission
- Without NIR point source
- Submm emission

The Samples

- Large Scale Molecular Line Survey for Cold IRAS Sources in the Galaxy ($\sim 70\%$) (2002ApJS141,157) Yang et al.
- Outflow Sample based on the Survey (36/44)
PI: Ruiqing Mao
- $C^{18}O$, ^{13}CO and CS maps based on the outflow sample (10)
PI: Ji Yang

Observation Of Outflow

HHT

Line: ^{12}CO J=2-1 or J=3-2

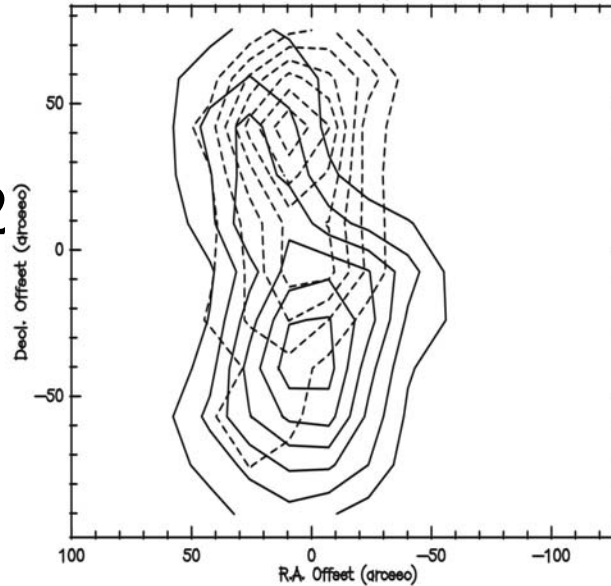
Detection Rate

$L > 1000 L_{\text{sun}}$: 27/31 ~ 87%

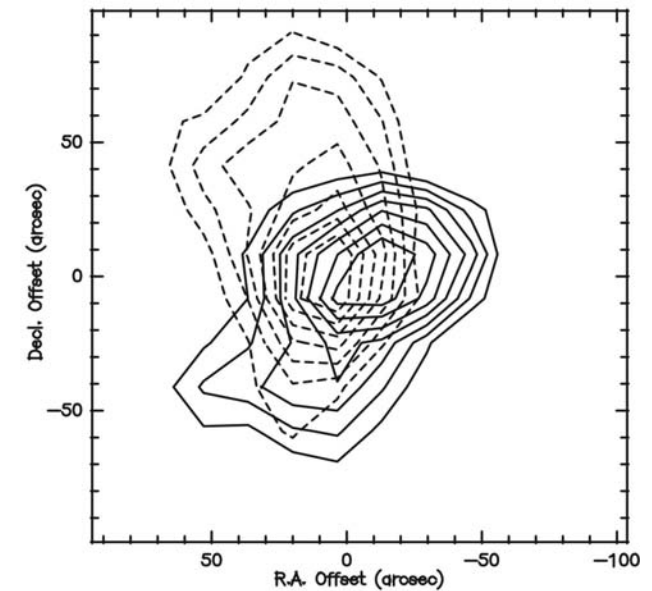
$L < 1000 L_{\text{sun}}$: 9/13 ~ 69%

Overall: 36/44 ~ 82%

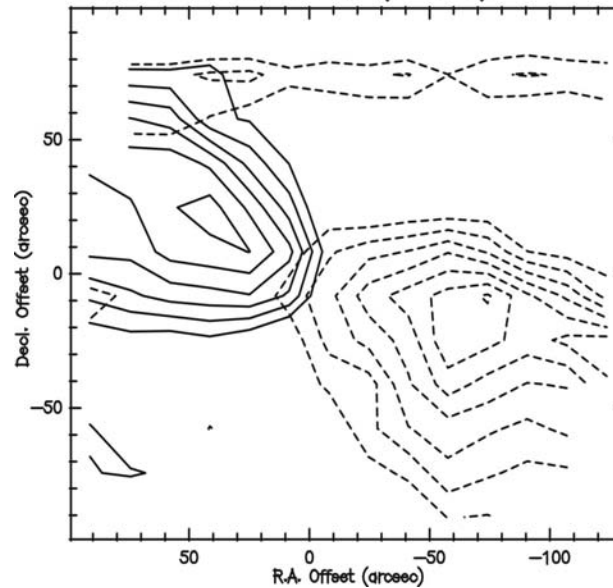
IRAS 00211+6549 CO (J=2-1)



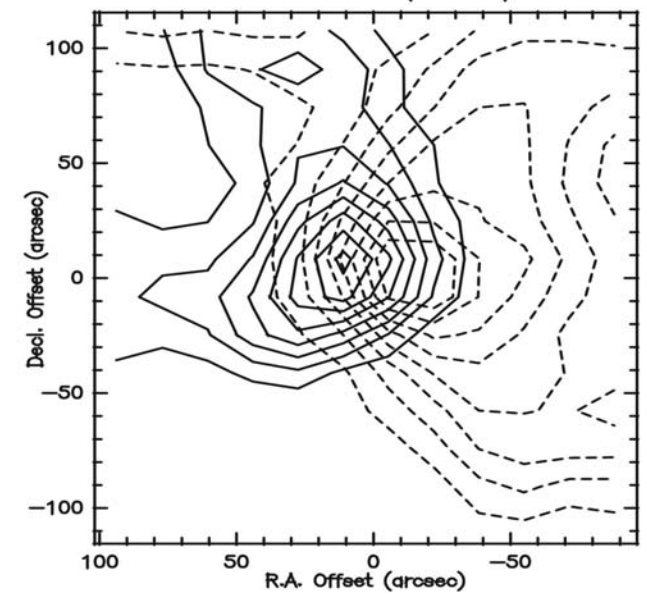
IRAS 02575+6017 CO (J=2-1)



IRAS 03445+3242 CO (J=2-1)

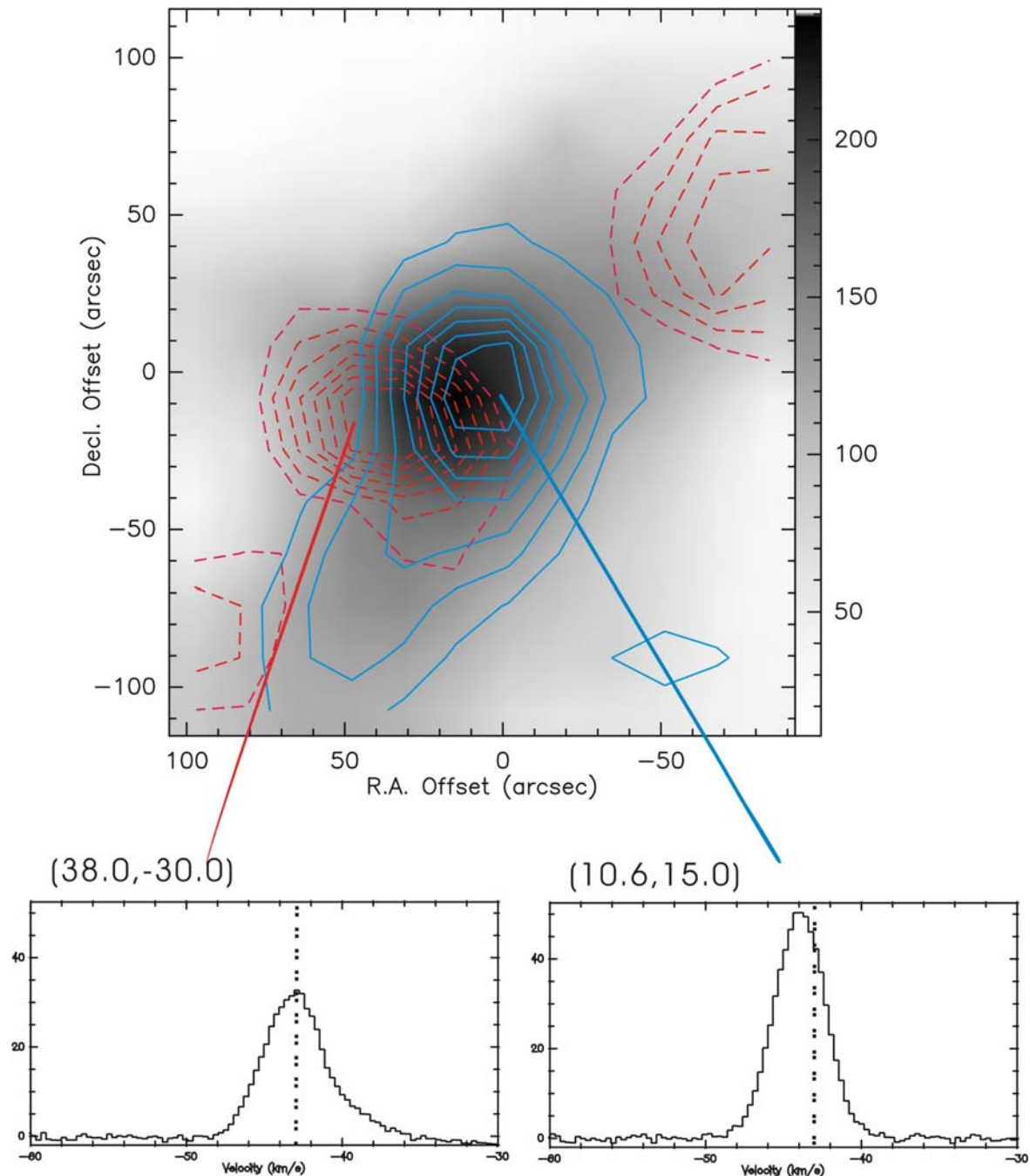


IRAS 18308-0503 CO (J=2-1)

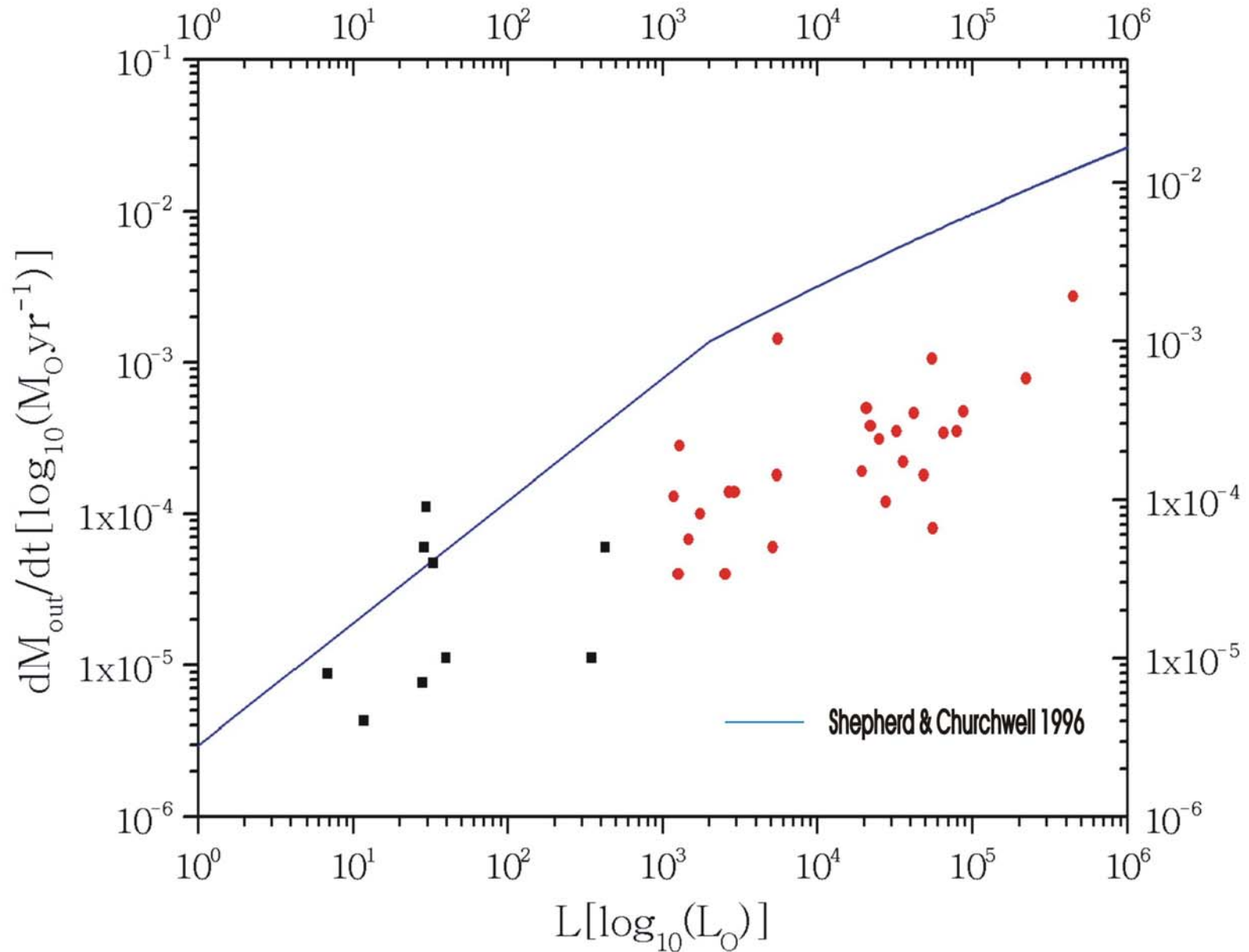


Outflow in IRAS 23138+5945

IRAS 23138+5945 CO (J=2-1)



Luminosity and Outflow Mass Rate



Observation Of Massive Dense Core

(I) ^{13}CO

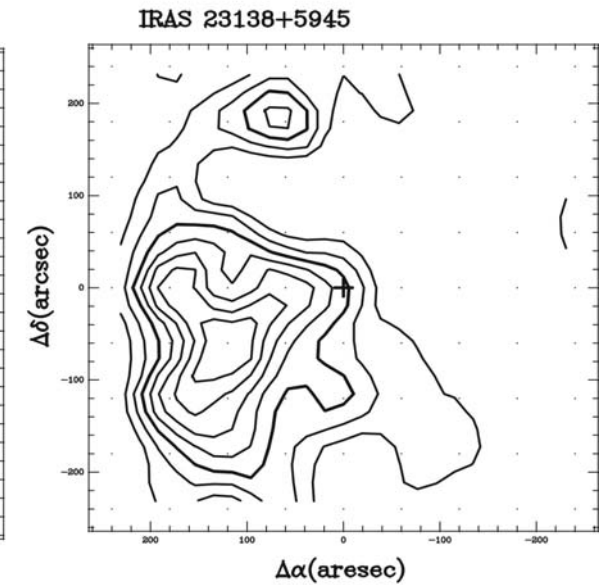
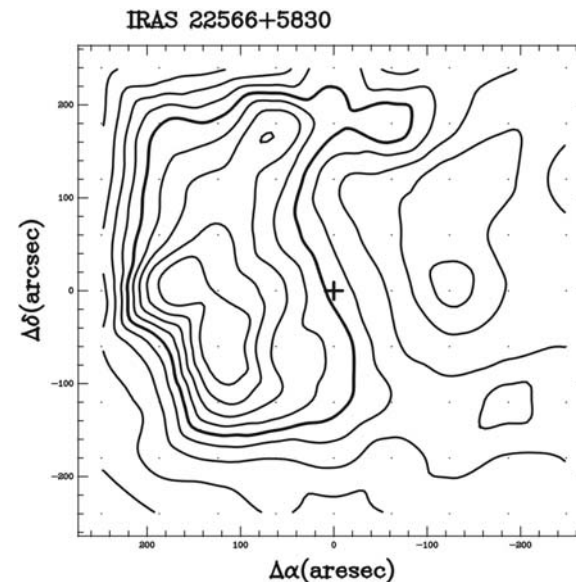
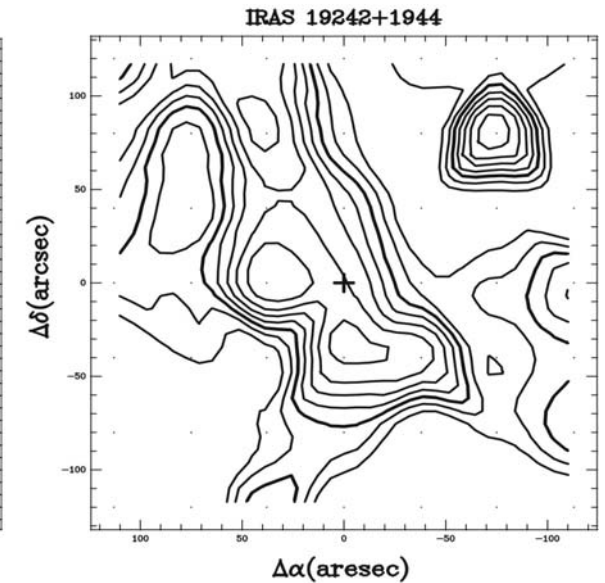
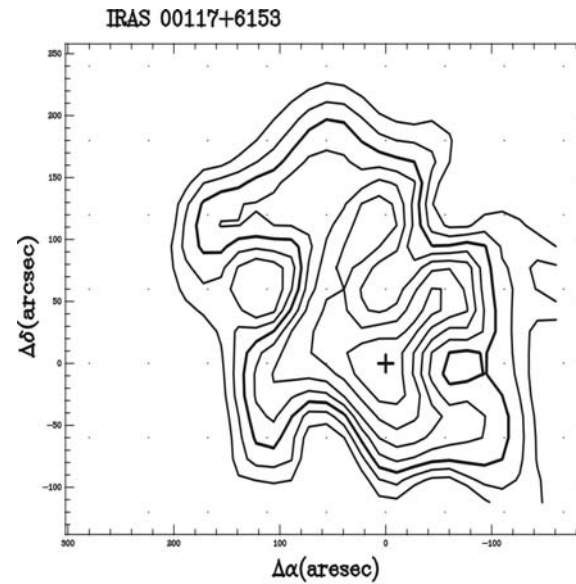
PMO13.7m

Line: ^{13}CO J=1-0

Detection rate:

10/10 ~ 100%

Rms: 0.37K



Observation Of Massive Dense Core (II) C¹⁸O

PMO13.7m

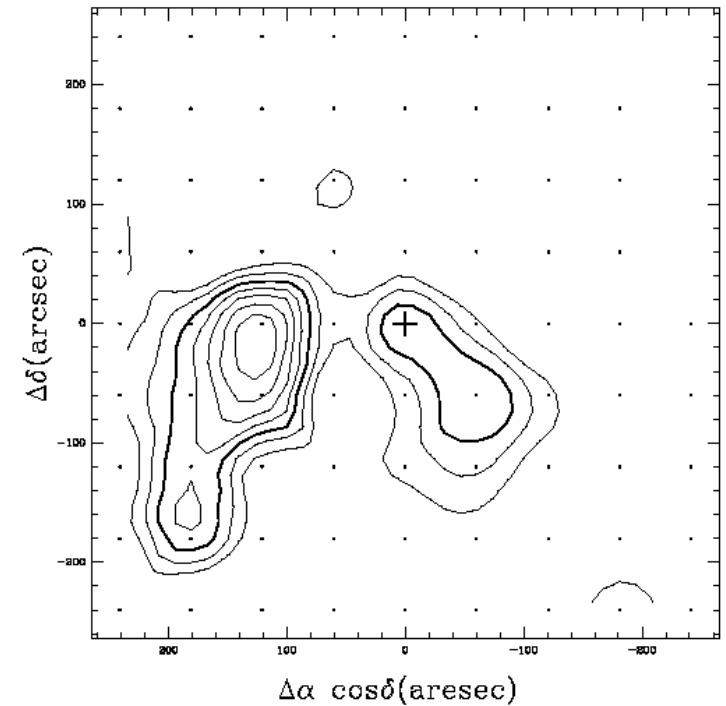
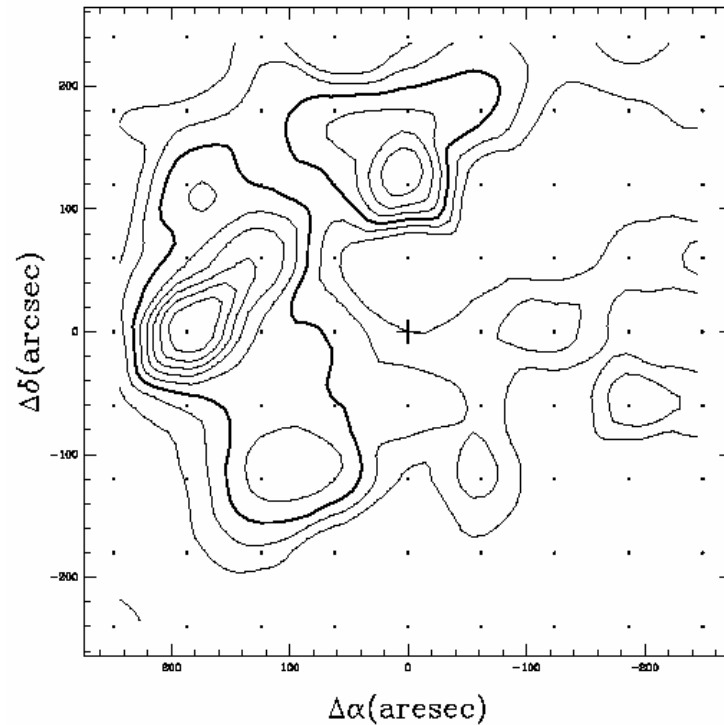
Line:

C¹⁸O J=1-0

Detection rate:

3/10 ~ 30%

Rms: 0.37K



Observation Of Massive Dense Core (III) CS

NRO45m

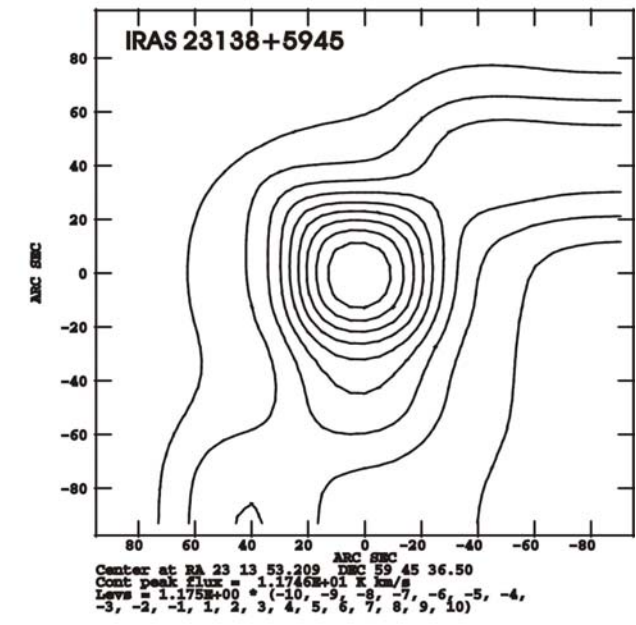
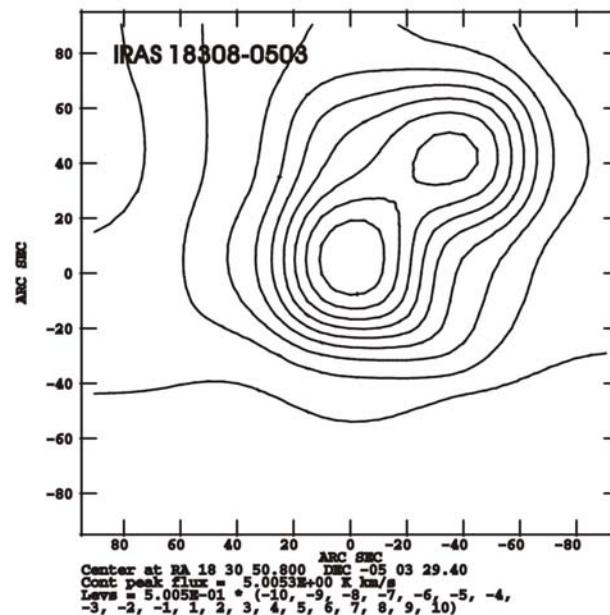
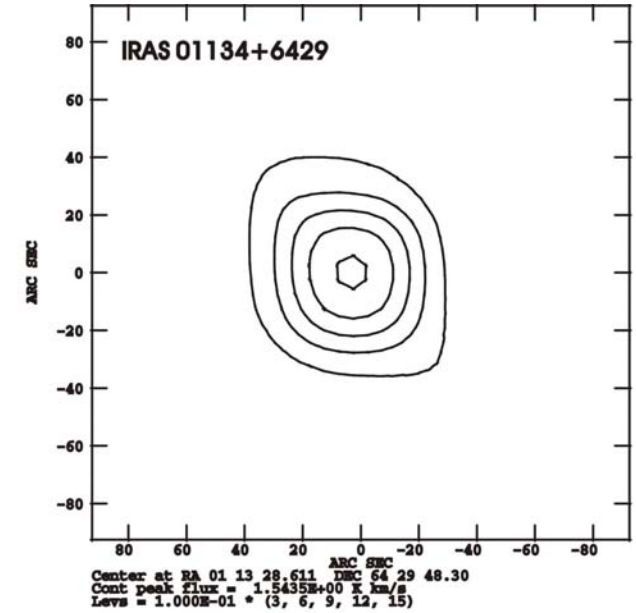
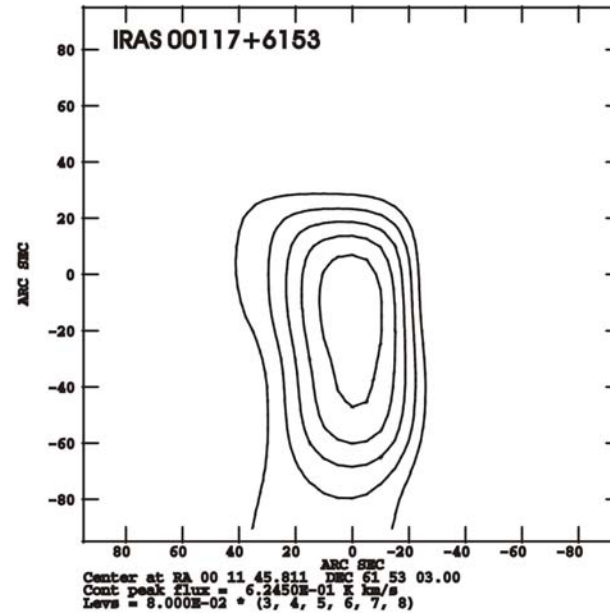
Line: CS J=2-1

Receiver :BEARS

Detection rate:

9/10 ~ 90%

Rms: 0.26 K



Some Parameters for the Sample

	¹³ CO	CS
$\Delta V(\text{km/s})$	2.7	2.1
L(pc)	4.3	1.1
M(M_{\odot})	3670	375
$M_{\text{VIR}}(M_{\odot})$	3830	471
L/ M_{VIR}	4.8	74
$\log n (\text{cm}^{-3})$	2.7	3.4

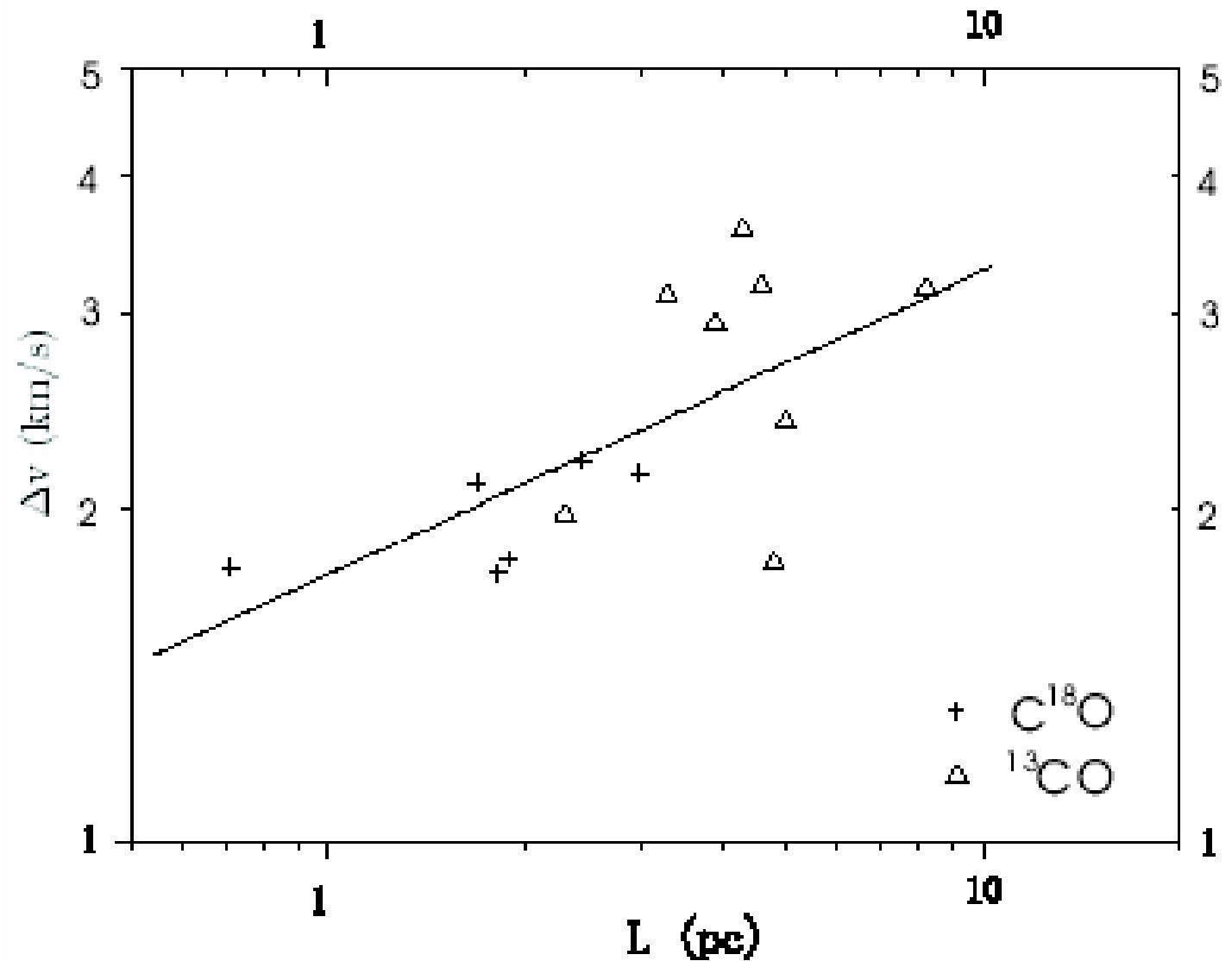
Linewidth-Size Relationship

$$\Delta V \sim R^{0.27 \pm 0.09}$$

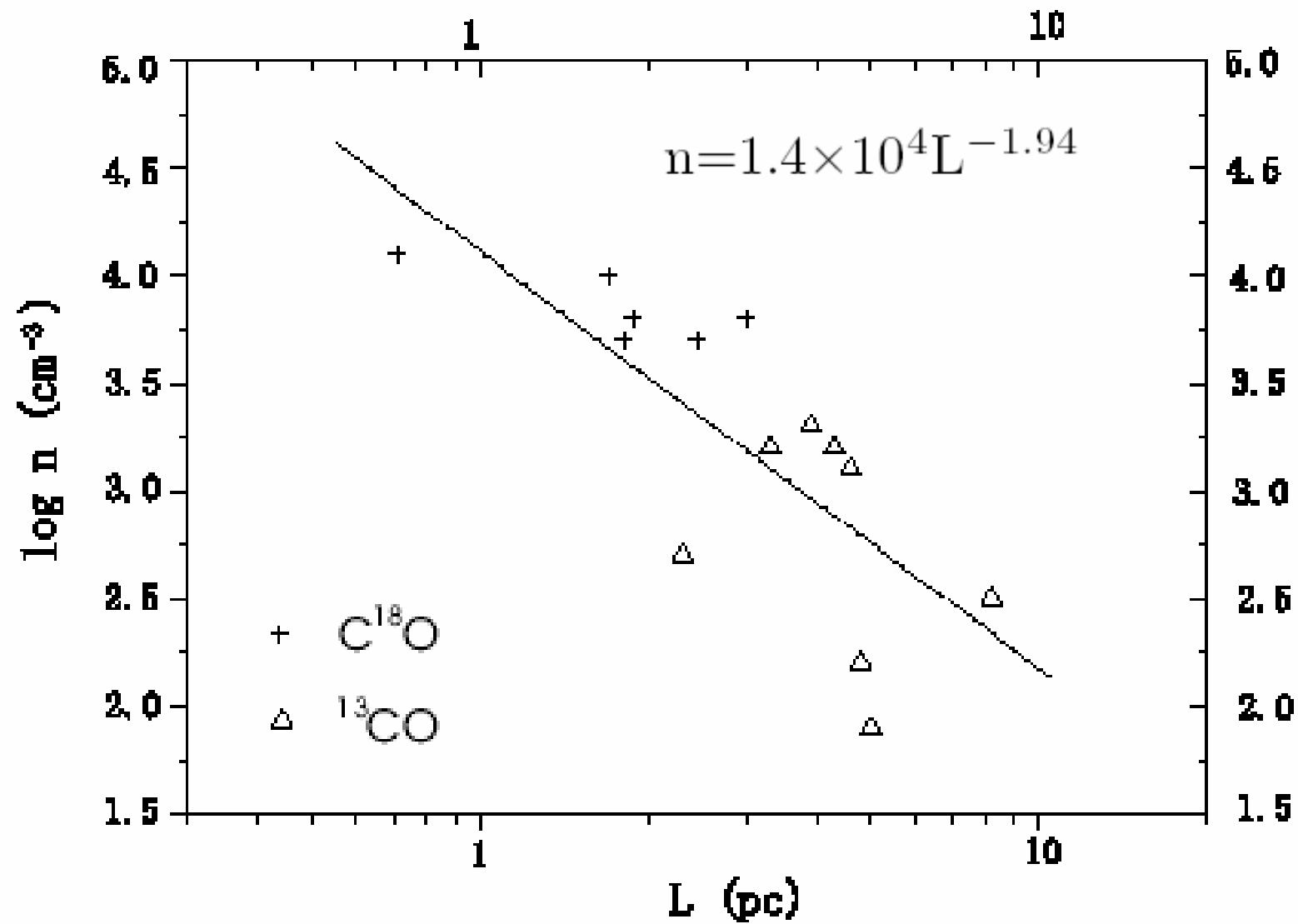
Caselli & Myers (1995)

$$\Delta V \sim R^{0.21 \pm 0.03} \text{ (HM)}$$

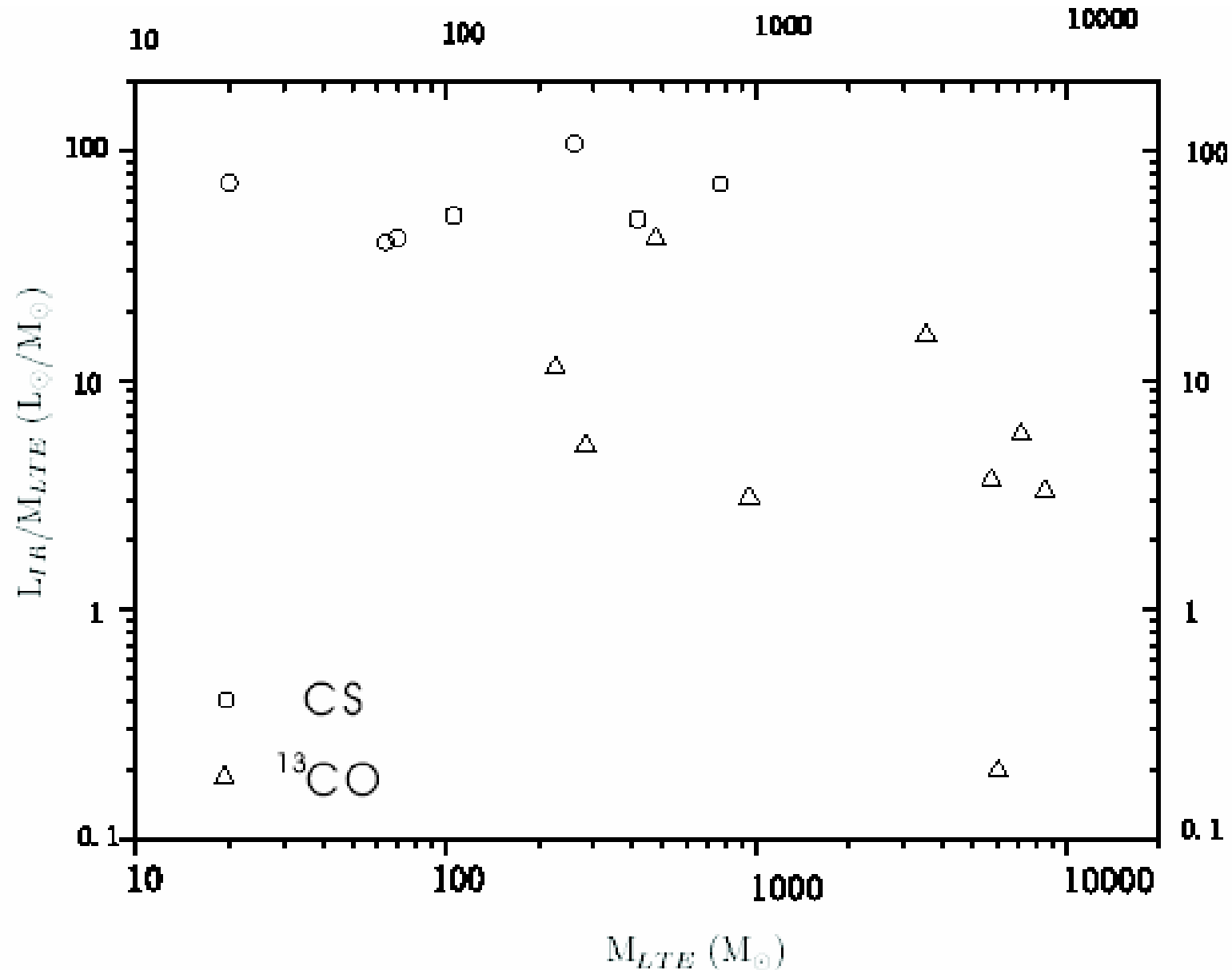
$$\Delta V \sim R^{0.53 \pm 0.07} \text{ (LM)}$$



Density vs. Size



Star Formation Rate per Unit Mass



Conclusion

- From the outflow sample, the results infer that the luminosity may be contributed by the cluster for the high luminosity sources.
- The parameters are obtained from the ^{13}CO and CS observations.
- The linewidth-size relationship is obtained
$$\Delta V \sim R^{0.27 \pm 0.09}.$$
- The density-size relationship is obtained, $n = 1.4 * 10^4 L^{-1.94}$
- The ratios of $L_{\text{IR}}/M_{\text{LTE}}$ vary no more than a factor of 3 for CS data and nearly 1 order or more for ^{13}CO data.