# Density structure of dense cores in the Cepheus molecular cloud

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**SUMMARY** We mapped 5 dense cores in the Cepheus molecular cloud in the optically thin $C^{18}O$ ($J = 1 - 0$) line using the 45-m telescope at Nobeyama and derived density profiles around those cores assuming spherical symmetry. Cloud cores are selected from the $^{13}CO$ ($J = 1 - 0$) map obtained through the unbiased survey program with the 4-m telescope at Nagoya university.

The results are summarized as below:

1. The cores with protostellar *IRAS* sources have the density profile consistent with the $r^{-2}$ distribution, being inferred from the quasi-static isothermal case, while those without *IRAS* sources tend to have less steep density gradient. (Fig. 1, Table 1)

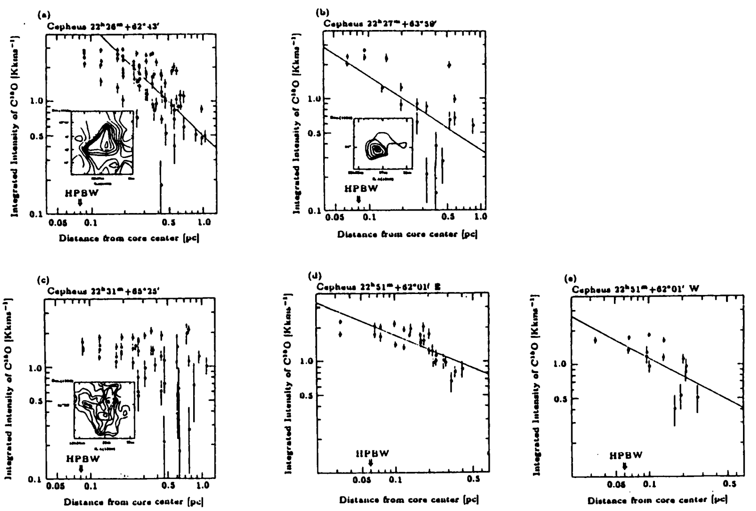


**Fig. 1** — The $C^{18}O$ intensity, i.e. the gas column density, is plotted as a function of radius measured from the centers of the observed cores with associated *IRAS* sources (a and b) and without *IRAS* sources (c, d, and e). The $C^{18}O$ intensity for the cores with embedded *IRAS* sources (a and b) significantly decreases with the increasing radius from the core centers, while for the cores without *IRAS* sources (c, d, and e) the $C^{18}O$ intensity remains relatively large even at large distances away from the centers. The straight lines show the result of least square fitting for the $C^{18}O$ intensity. The map obtained with 4-m telescope at Nagoya university is inserted (a, b, and c).



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2. All the observed cores are stable in gravitational equilibrium. (Table 1)
3. The cores with steeper density gradient have larger average column density toward their centers. (Fig. 2)

These results suggest that cores with less steep density gradient contract in a quasi-static manner under gravitational equilibrium and evolve into cores with steeper density gradient to form protostars at their centers.

Table 1

| [1] Core Name | [2] $\tau(C^{18}O)$ | [3] $T_{ex}$ (K) | [4] $\alpha$ | [5] Size (pc) | [6] $N(H_2)$ ($\times 10^{21} cm^{-2}$) | [7] Velocity gradient ($kms^{-1}pc^{-1}$) | [8] Mass ($M_\odot$) | [9] Virial Mass ($M_\odot$) |
|---|---|---|---|---|---|---|---|---|
| with an IRAS point source | | | | | | | | |
| $22^h26^m+62°43'$ | 0.05 | 33 | -1.0 | 0.27 | 16.1 | 2.6 | 122 | 128 |
| $22^h27^m+63°59'$(1) | 0.10 | 13 | -0.8 | 0.20 | 14.3 | 2.6 | 16 | 74 |
| without an IRAS point source | | | | | | | | |
| $22^h31^m+65°25'$ | 0.12 | 15 | 0(2) | 0.40 | 10.5 | 1.6 | 83 | 109 |
| $22^h51^m+62°01'E$(1) | 0.12 | 19 | -0.4 | 0.21 | 12.5 | — | 37 | 92 |
| $22^h51^m+62°01'W$(1) | 0.15 | 16 | -0.5 | 0.15 | 10.0 | 3.0 | 11 | 56 |

note) (1) These cores are associated with HII region.
(2) Correration coefficient is 0.3.

**Table 1** — We estimated the power law indices of the column density distribution from the least square fitting (column 4). This result suggests that the density profiles of the cores with *IRAS* sources are consistent with the $r^{-2}$ distribution under the assumption of spherical symmetry. On the contrary, cores without *IRAS* sources have less steep density gradient. The mass estimated from the observed column density (column 8) agrees well with the dynamical mass estimated from the observed line width (column 9), suggesting that these cores are in gravitational equilibrium.

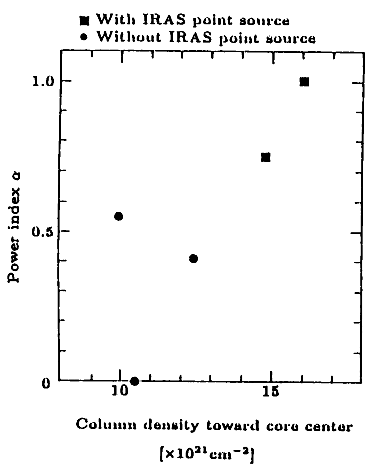


**Fig. 2** — This figure shows the power law indices of the column density profiles versus the column density averaged over the radius of 0.15 pc around the core centers. The cores with steeper density gradient have larger average column density toward them.

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