Turbulence in TMC1-C and ρ-Oph core

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SUMMARY We made ^{13}CO and $C^{18}O$ (both $J = 1 - 0$) maps of the $4' \times 4'$ (0.2 pc $\times$0.2 pc) area toward TMC1-C and ρ-Oph core with the 45-m telescope of the Nobeyama radio Observatory in order to find small scale velocity fluctuation in molecular clouds based on the analysis described by Kleiner and Dickman (1987).

We found followings:

1. The coherent length in TMC1-C is 0.02 pc, which is of order smaller than the value 0.1 pc derived by Kleiner and Dickman. We obtained the smaller coherent length because the large scale systematic velocity gradient corresponding to the size scale of 0.1 pc is subtracted before the analysis. The presence of the new scale means that turbulence is actually hierarchical down to 0.02 pc.

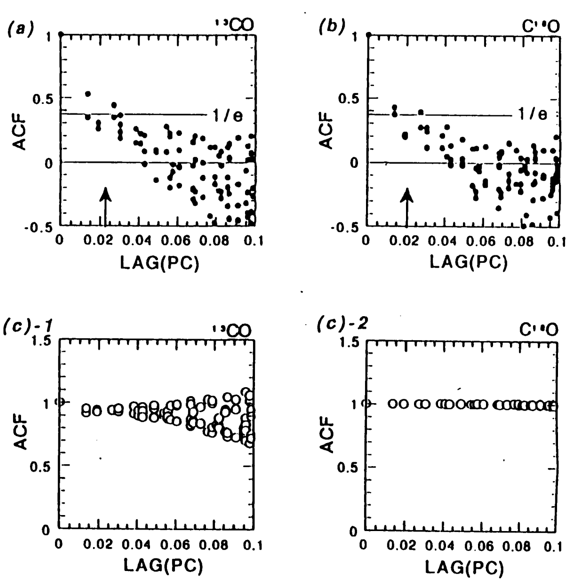

Fig. 1 — These figures show auto-correlation functions (ACF) in TMC1-C for (a) ^{13}CO and (b) $C^{18}O$ measurements. Figure (c) shows the ACF for which large scale systematic velocity gradient corresponding to the size scale of 0.1 pc has not been subtracted. The coherent length, i.e, the e-folding length of ACF, is 0.02 pc for both ^{13}CO and $C^{18}O$, being smaller than the value of 0.1 pc derived by Kleiner and Dickman(1987) because of the subtraction of the large scale systematic velocity gradient shown in (c). Our result means that turbulence has a coherent length as small as 0.02 pc, suggesting that **turbulence in molecular clouds is hierarchical down to this small scale length.**

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2. The small scale coherent length in TMC1-C (0.02 pc) is significantly smaller than that in ρ-Oph core (0.03 pc measured for $C^{18}O$ and 0.04 pc for ^{13}CO). This may be related to the recent observational result that typical masses of newly formed stars in Taurus are significantly smaller than those in ρ-Oph (Cohen and Kuhi 1979, Rieke *et al.* 1989), suggesting that turbulence plays an important role in determining stellar masses, or vice versa.

Reference

Cohen, M., and Kuhi, L. V. 1979, *Ap. J. Suppl.*, 41, 743
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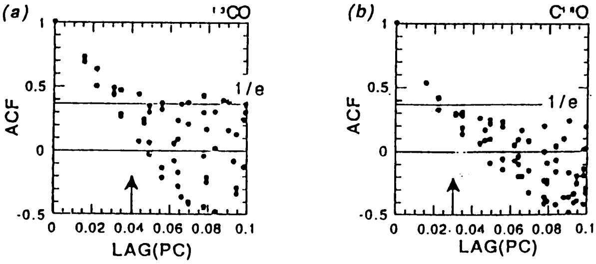

Fig. 2 — ACFs measured in ρ-Oph core are shown for (a) ^{13}CO and (b) $C^{18}O$. The correlation lengths are 0.03 pc for $C^{18}O$ and 0.04 pc for ^{13}CO, respectively. These correlation lengths are significantly larger than the value for TMC1-C (0.02 pc), even when the effect of degradation for coherent length due to noise is taken into account. We conclude that the coherent length of turbulence is different among molecular clouds.

Table 1

	TMC1-C		ρ-Oph core	
Distance(pc)	140		160	
Mapping Area	0.16 pc ×0.16 pc		0.19 pc ×0.19 pc	
T_{ex}(K) (1)	11		53	
	^{13}CO	$C^{18}O$	^{13}CO	$C^{18}O$
τ ($C^{18}O$) (1)		0.55		0.15
Coherent length(pc)	0.02	0.02	0.04	0.03
Corrected Factor (2)	1.22	1.20	1.06	1.04
Corrected	0.024 pc	0.024 pc	0.04 pc	0.03 pc
Mass($M_\odot$)		0.3		3.7

note) (1) These values are averaged all over the observed positions. These values at each position are obtained by the assumption of LTE and of the abundance ratio ($X(^{13}CO)/X(C^{18}O)$) is 5.5.

(2) This value reveale the degree of the decorrelated due to the ramdom noise. The way of the estimation are followed by Kleiner and Dickman.

Table 1 — This table shows the total mass contained inside the coherent length for TMC1-C and ρ-Oph core. The mass in the coherent length in ρ-Oph core is $\sim$ 10 times larger than that in TMC1-C. This may be related to the recent results that ρ-Oph core tends to produce relatively high mass stars (Rieke *et al.*1989), while solar-type stars are predominantly formed in TMC (Cohen and Kuhi, 1979), suggesting that turbulence plays an important role in determining stellar masses.