

# Internal $^{13}\text{CO}$ structures within molecular clouds

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**Aims:** to characterize the internal  $^{13}\text{CO}$  structures within  $^{12}\text{CO}$  molecular clouds (MCs) by their gas fractions, spatial distribution, and relative motions.

**Samples:** 2851 MCs identified from the MWISP CO survey crossing  $l = (105^\circ \text{ } 150^\circ)$  &  $|b| < 5.25^\circ$  &  $V_{\text{LSR}} = (-95 \text{ } 25) \text{ km s}^{-1}$ ; Near group in  $(-30 \text{ } 25) \text{ km s}^{-1} \sim 0.5 \text{ kpc}$ , Far group in  $(-95 \text{ } -30) \text{ km s}^{-1} \sim 2 \text{ kpc}$ ;  $^{12}\text{CO}$  lines (RMS  $\sim 0.5\text{K}@0.2\text{km s}^{-1}$ ) &  $^{13}\text{CO}$  lines (RMS  $\sim 0.3\text{K}@0.2 \text{ km s}^{-1}$ )

## (1) Denser molecular structures traced by $^{13}\text{CO}$ lines (Yuan & Yang et al. 2022, ApJS, 261:37)

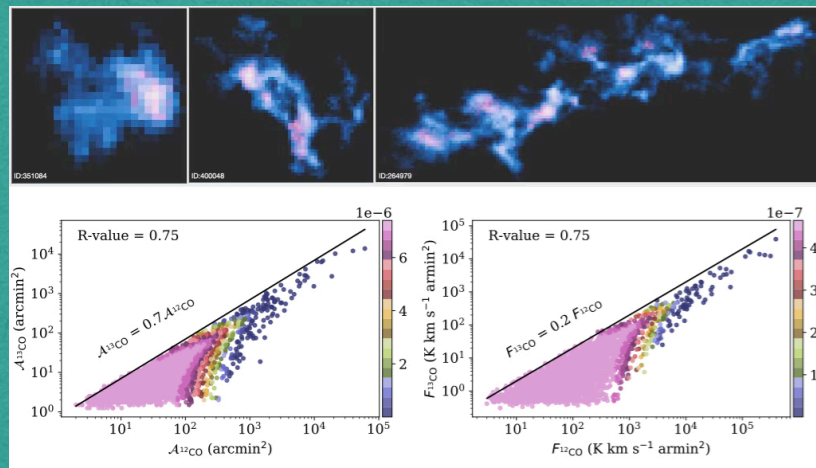
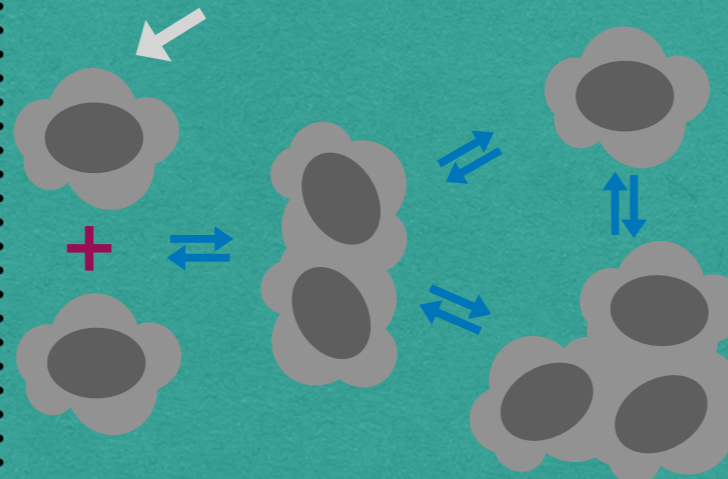


Fig1: R-values is the Spearman's correlation coefficient. The colors on the dots represent the distribution of 2D-PDF.

## Internal $^{13}\text{CO}$ structures:

- (1) Their overall emission areas generally do not exceed 70% of MC's  $^{12}\text{CO}$  emission areas.
- (2) Regularly spaced and has a preferred separation.
- (3) Their relative velocity dispersions are the main form to store the kinetic energy of MCs
- (4) Their relative motions are random.

$^{13}\text{CO}$  structures act as the building blocks of MCs and units of material transfer between MCs.



## (3) Relative velocity dispersions between $^{13}\text{CO}$ structures (Yuan & Yang et al. 2023b, ApJ, 958:7)

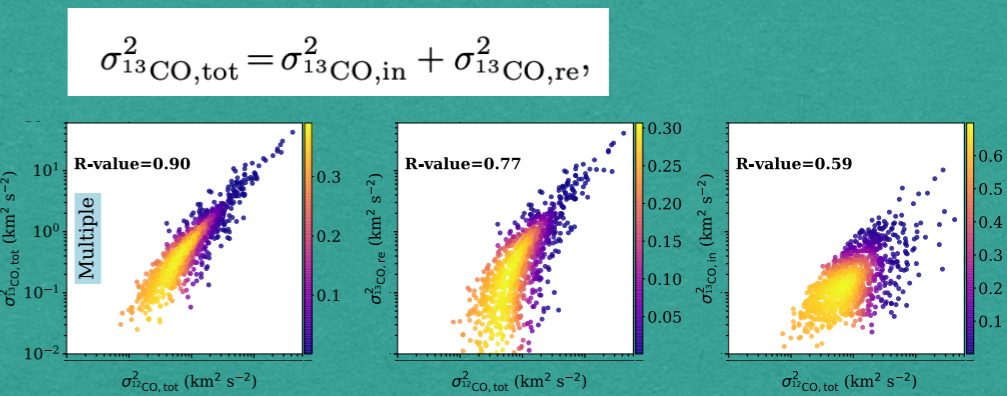
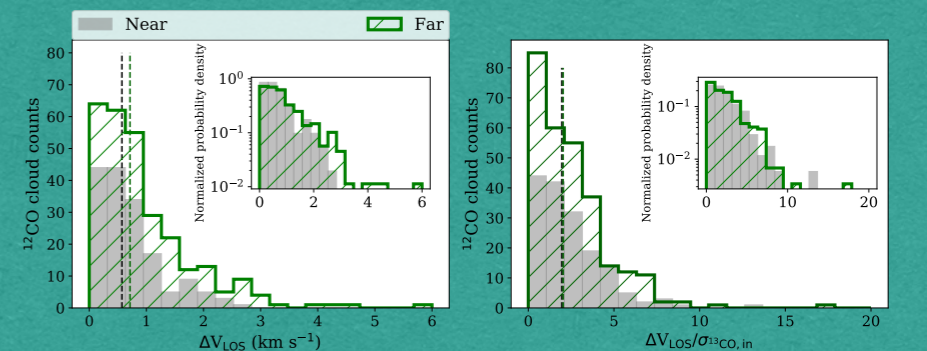


Fig3: R-values is the Spearman's correlation coefficient. The colors on the dots represent the distribution of 2D-PDF.

## (4) Relative velocities between $^{13}\text{CO}$ structures (Yuan & Yang et al. 2024, AJ, 167:207)



$\sim 40\%$  of MCs:  $\Delta V_{\text{LOS}} >$  linewidths of  $^{13}\text{CO}$  structures

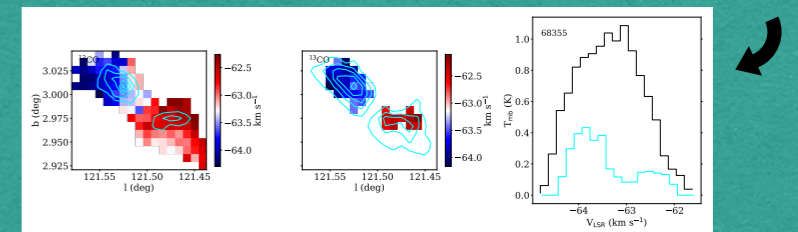


Fig4: Velocity fields of MCs with double  $^{13}\text{CO}$  structures,

## (2) A preferred separation between $^{13}\text{CO}$ structures (Yuan & Yang et al. 2023a, ApJ, 944:91)

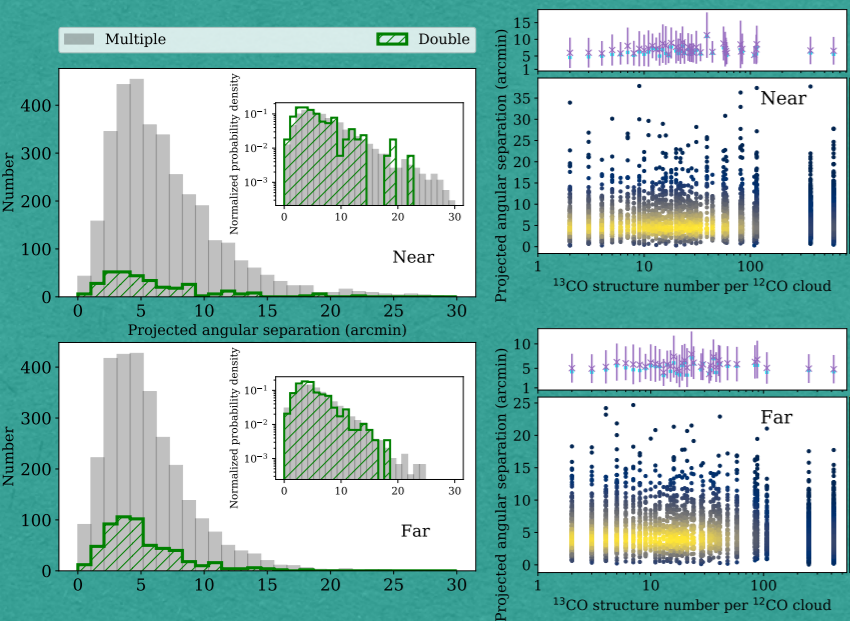


Fig2: The colors on the dots represent the distribution of 2D-PDF.