

## ALMA observations of layered structures due to CO selective dissociation in the $\rho$ Ophiuchi A plane-parallel PDR

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One of the outstanding issues in current PDR study is that there is no unified understandings about the PDR spatial structure. An important approach to examine the PDR spatial structure is observation of CO selective dissociation with high spatial resolution. A plane-parallel PDR is expected to make CO layered structures due to selective dissociation at the PDR interface from more- to less-abundant isotopologues as a function of distance from the excitation star, while a clumpy PDR is difficult to make such layered structures. We analyzed  $^{12}\text{CO}(2-1)$ ,  $^{13}\text{CO}(2-1)$ ,  $\text{C}^{18}\text{O}(2-1)$ , and 1.3 mm continuum maps of the  $\rho$  Ophiuchi A PDR obtained with ALMA. Layered structures of the three CO isotopologues with an angular separation of  $10'' = 6.6 \times 10^{-3} \text{ pc} = 1400 \text{ au}$  are clearly detected around the excitation star. We estimated the spatial variations of  $X(^{13}\text{CO})/X(\text{C}^{18}\text{O})$  abundance ratios, and found that the abundance ratio is as high as 40 near the emission front, and decreases to the typical value in the solar system of 5.5 in a small angular scale of  $4'' = 2.6 \times 10^{-3} \text{ pc} = 560 \text{ au}$ . We also found that the  $I(^{12}\text{CO}(2-1))/I(^{13}\text{CO}(2-1))$  intensity ratio is very high ( $>27$ ) in the Class II young stellar object, GY-51, located in the PDR. The enhancement of the ratios indicates that the UV radiation significantly affects the CO isotopologues via selective dissociation in the overall  $\rho$  Ophiuchi A PDR, and that the  $\rho$  Ophiuchi A PDR has a plane-parallel structure.

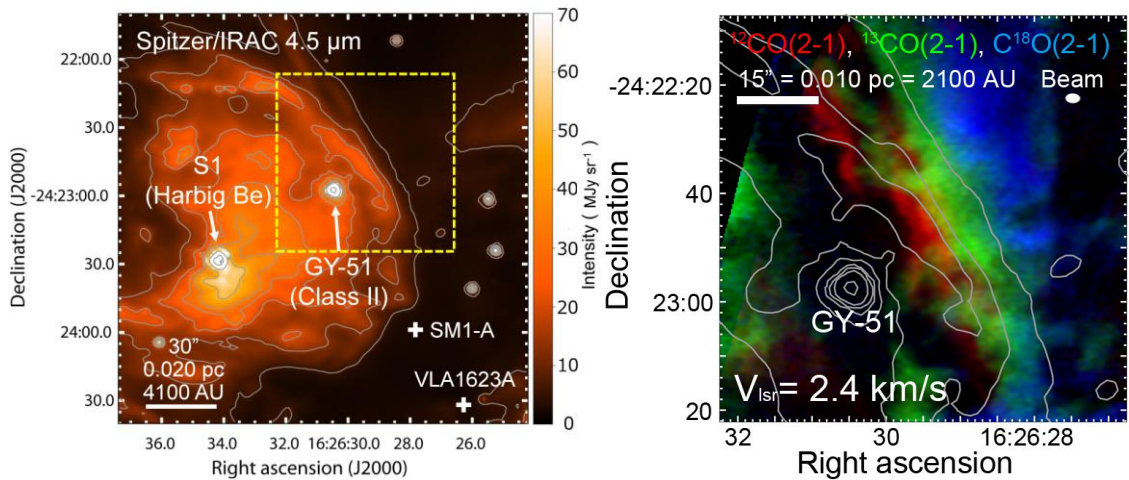


Figure 1: (left) Spitzer/IRAC 4.5  $\mu\text{m}$  map of  $\rho$  Oph A. The yellow dashed box indicates the target area in the present study. (right) Color-composite maps of (red)  $^{12}\text{CO}(2-1)$ , (green)  $^{13}\text{CO}(2-1)$ , and (blue)  $\text{C}^{18}\text{O}(2-1)$  emissions at  $V_{\text{lsr}}=2.4 \text{ km/s}$ . Contours are the same as in the left panel.