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APERTURE SYNTHESIS MAPS OF NH_2D AND CH_3OD LINES TOWARD ORION-KL: THE ORIGIN OF NH_3 AND CH_3OH

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ABSTRACT The 1_{11-}-1_{01+} transition of NH_2D and the 2_1-2_0 E transition of CH_3OD were mapped toward Orion-KL with the Nobeyama Millimeter Array. The synthesized beamwidth is 4" to 5". NH_2D and CH_3OD are mainly distributed over the peak-intensity regions of NH_3 and CH_3OH in Orion A, respectively. These results suggest that "most" of the gas-phase ammonia and methanol in the region of Orion-KL originate from dust grains.

INTRODUCTION

The high abundance of deuterated isotopes of interstellar molecules has been a topic of extreme interest in interstellar chemistry. Large deuterium enhancement has been found in the relatively hot (T=50-150 K) region of Orion-KL:[HDCO]/[H_2CO]=0.01-0.03 (Loren and Wootten, 1985), [NH_2D]/[NH_3]=0.03 (Walmsley et al. 1987), [HDO]/[H_2O]=0.001 (Petuchowski and Bennett, 1988), [CH_3OD]/[CH_3OH]=0.01-0.06 (Mauersberger et al. 1988). The abundance ratios of the deuterated species to the parent species are more than two orders of magnitude larger than the interstellar D/H ratio. The large deuterium fractionation suggests that the molecules are produced at temperatures of 10 K or less(Dalgarno and Lepp, 1984).

So as to determine the detailed distribution of deuterated species in the hot region, we mapped the lines of NH_2D and CH_3OD toward Orion-KL with the Nobeyama Millimeter Array.

RESULTS AND DISCUSSION

Observations were made during January to April, 1992 (3 days). The observed lines are the 1_{11-}-1_{01+} transition of NH_2D at 110.153599 GHz and the 2_1-2_0 E transition of CH_3OD at 110.262640 GHz. The synthesized beam sizes were 5"×4" for NH_2D and 4"×4" for CH_3OD. The integrated intensity maps are shown in Fig. 1. A comparison between the distribution of the NH_3, J, K=1, 1 line (Murata et al. 1990) and that of NH_2D shows that the distribution of NH_2D corresponds to the main peak region of NH_3 at 5.4" south by southwest of IRc2, the hot core region. The distribution of CH_3OD also corresponds to the main peak region of CH_3OH (Plambeck and Wright, 1988) midway between IRc4 and IRc5, the north side of the compact ridge.

Plambeck and Wright (1987), and Walmsley et al. (1987) suggest that the highly deuterium-fractionated species are formed on dust grains which memorize the cold conditions of the molecular cloud before the young star, IRc2, switched on, and we are observing nonsteady-state conditions of the evaporated gases in the region. The present result is consistent with their model and, furthermore, implies that "most" of the gas-phase NH_3 and CH_3OH in the Orion-KL region originate from dust grains. Finally, it must be noted that the distributions of $(CH_3)_2O$ and $HCOOCH_3$ (Mikami et al. 1992) also coincide with the main peak-intensity region of CH_3OH and, as a result, $(CH_3)_2O$ and $HCOOCH_3$ in the Orion-KL region may also originate from the same dust grains from which methanol is evaporated.

In conclusion, it has been demonstrated that a detailed study on the distributions of deuterated species is a method to get an insight into the mechanism for interstellar molecular production whether it be via gas-phase ion-molecule or dust-grain related reactions.

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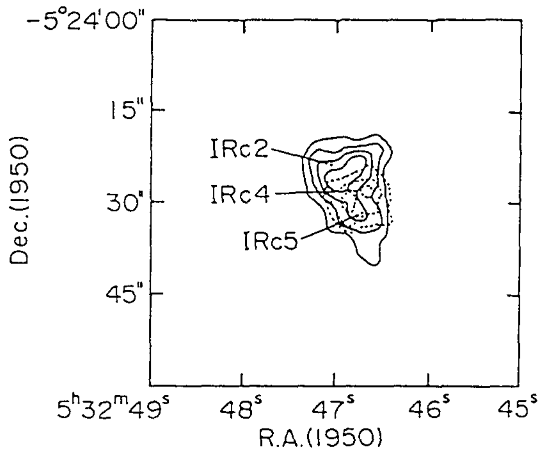

Fig. 1. The total integrated maps of $NH_2D(1_{11-}\text{-}1_{01+})$ with the peak flux of 0.66 Jy beam $^{-1}$ (solid contour) and $CH_3OD(2_1\text{-}2_0\ E)$ with 0.58 Jy beam $^{-1}$ (dashed contour). The lowest contour and the contour interval are 2σ.

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