PRECISE DETERMINATION OF THE ISOTOPIC RATIOS OF HC$_3$N IN THE MASSIVE STAR-FORMING REGION Sgr B2(M)

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Isotopic ratio is a critical parameter in understanding galactic chemical evolution. In addition, carbon isotopic ratio of an organic molecule reflects its formation mechanism. In the present study, we observed the simplest cyanopolyne HC$_3$N and its isotopomers in the massive star-forming region Sgr B2(M) with Nobeyama 45 m radio telescope. The column density and the rotational temperature of HC$_3$N were determined to be $1.6 \times 10^{15}$ cm$^{-2}$ and 163 K, respectively. The ratios of the column densities for the $^{13}$C isotopomers were derived to be [H$^{13}$CCCN]:[HC$^{13}$CCN]:[HCC$^{13}$CN] = 1:1.03(4):0.99(3), where the rotational temperature was fixed to that of HC$_3$N. The ratios are almost the same, suggesting no isotopic fractionation for the specific carbon atoms in HC$_3$N. Therefore, it is considered that the $^{13}$C isotope exchange reactions do not contribute to make difference among the column densities of the three $^{13}$C isotopomers in the relatively warm region of Sgr B2(M). In contrast, the reported ratios in TMC-1 and L1527 are 1:1.01(2):1.35(3), respectively, where the ratios show higher abundance of HCC$^{13}$CN.

We also observed the transitions in the vibrational excited states of HC$_3$N. The rotational temperature of 362 K in the $\nu_4$, $\nu_5$, $\nu_6$ and $\nu_7$ excited states was obviously different from that of the vibrational ground state.

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