Precise determination of the isotopic ratios of HC_3N 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 particular, ^{13}C isotopic ratio of an organic molecule reflects its formation mechanism. In the present study, we observed the simplest cyanopolyyne HC_3N and its isotopomers in the massive star-forming region Sgr B2(M) with Nobeyama 45 m radio telescope. Fig. 1 shows the observed peaks of the $J = 10-9$ transition. The column density and the rotational temperature of HC_3N were determined to be 1.6×10^{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: 04(4):1.01(4), where the rotational temperature was fixed to that of HC_3N. The ratios are almost the same. It is considered that the ^{13}C isotope exchange reactions do not contribute to make slight difference between the column densities of the three ^{13}C isotopomers in the relatively warm region Sgr B2(M). Therefore, we concluded that there is no isotopic fractionation for the specific carbon atoms in HC_3N. We also observed the transitions in the vibrational excited states of HC_3N. The rotational temperature of 352 K determined was obviously different from that of the vibrational ground state.

In addition, we observed the peak of the $J = 10-9$ transition of $HC_3{}^{15}N$ as shown in Fig. 1. The $^{14}N/^{15}N$ ratio was tentatively determined to be ~99 in Sgr B2(M), which agrees with that estimated by Adande *et al* (123.8 ± 37.1) [1]. It is considered that this ratio reflects difference of nucleosynthesis processes between ^{14}N and ^{15}N atoms.

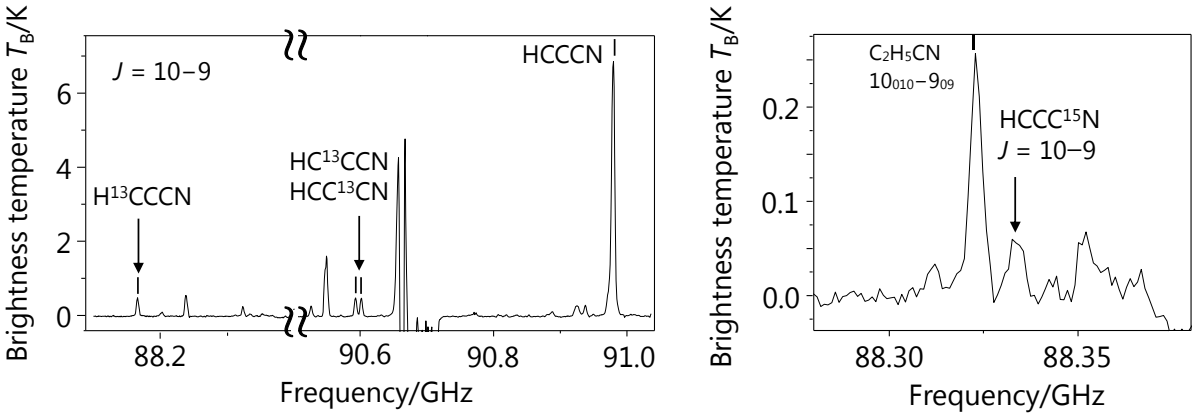

Figure 1: The $J = 10–9$ transitions of HC_3N observed toward Sgr B2(M) with Nobeyama radio telescope. Left panel: the lines of HCCCN, H^{13}CCCN, HC^{13}CCN and HCC^{13}CN. Right panel: the line of HCCC^{15}N.

Reference: [1] G. R. Adande and L. M. Ziurys, *ApJ*, **744**, 194 (2012).