Investigation of ^{13}C isotopic fractionation of HC_5N in TMC-1

K. Taniguchi,[1, 2] S. Takano,[2, 3] H. Ozeki,[1] N. Sakai,[4] S. Yamamoto,[4]
F. Nakamura,[3, 5] and Z45 group

[1]*Department of Environmental Science, Faculty of Science, Toho University, Japan*
[2]*Nobeyama Radio Observatory, NAOJ, Japan*
[3]*Department of Astronomical Science, School of Physical Science, The Graduate University for Advanced Studies, Japan*
[4]*Department of Physics, Faculty of Science, The University of Tokyo, Japan*
[5]*Devision of Theoretical Astronomy, NAOJ, Japan*

Around 180 molecules have been detected in the interstellar medium (ISM) or circumstellar shells until now, and approximately 40 % of the molecules in space are classified into carbon-chain molecules. Therefore, it is important for astrochemistry to study these molecules. The formation mechanisms of some of the carbon-chain molecules, which are abundant in the ISM, have been studied by observations of ^{13}C isotopic fractionation of these molecules (N. Sakai *et al*. summarized [1]), including HC_3N [2], which is the shortest carbon-chain molecule of cyanopolyynes. This observation aims at clarifying the formation mechanism of HC_5N, which is the second shortest carbon chain of cyanopolyynes.

We used the 45m telescope of Nobeyama Radio Observatory, and conducted observation in 2014 March and April. We used the Z45 receiver, which is the low noise receiver at 45 GHz region, and analyzed by a smoothed bandpass calibration method [3]. The observed source was the cyanopolyyne peak in Taurus Molecular Cloud -1 (TMC-1) (R.A. = $4^h\ 41^m\ 42^s.29$, Decl. = 25° 41’ 27”.0, J2000). Normal species and five ^{13}C isotopologues of HC_5N were measured using the J = 16 – 15 rotational transition at 42 GHz region. We got the spectra with the signal-to-noise ratio between 12 and 14.5 (Fig.1).

There is no clear ^{13}C isotopic fractionation among the five ^{13}C isotopologues of HC_5N. From these observational results, we concluded that the growth of the carbon chain of HC_3N, which was considered as one of the most possible formation mechanisms of HC_5N, HC_7N and so on, may not be an important formation mechanism of HC_5N, because ^{13}C isotopic fractionation of HC_5N does not clearly reflect that of HC_3N. We think at the present stage that HC_5N is presumably formed by reaction with nitrogen atom [4], not with CN radical as in the case of HC_3N. Therefore, cyanopolyynes are probably not mainly produced by the sequential carbon-chain growth of the shorter member.

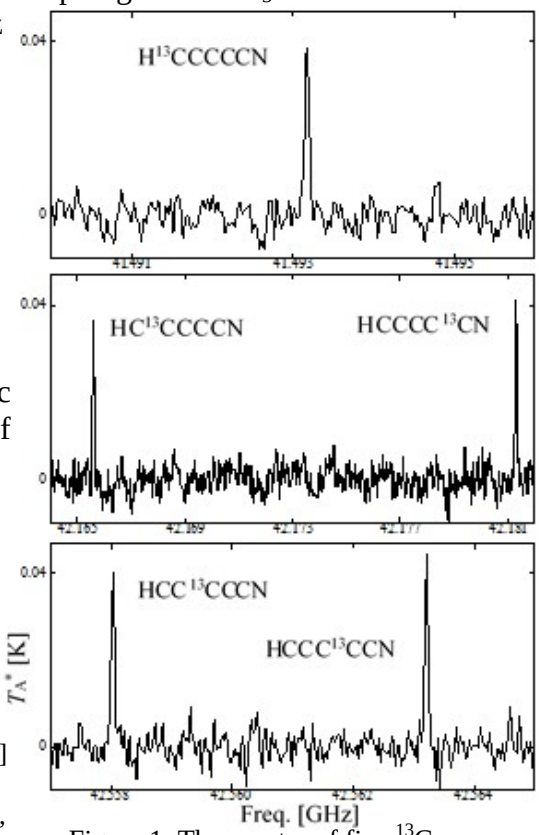

Figure 1: The spectra of five ^{13}C isotopologues of HC_5N

References

[1] N. Sakai *et al*., *J. Phys. Chem. A*, **117(39)**, 9831 (2013). [2] S. Takano *et al*., *Astron. Astophys.*, **329**, 1156 (1998). [3] H. Yamaki *et al*., *PASJ*, **64**, 118 (2012). [4] A. J. Markwick *et al*., *ApJ*, **535**, 256 (2000).