

## A search for the HOCO radical in the massive star-forming region Sgr B2(M)

Rin Abe,<sup>1</sup> Ayane Miyazaki,<sup>1</sup> Takahiro Oyama,<sup>1</sup> Mitsunori Araki,<sup>1</sup> Shuro Takano,<sup>2</sup>  
Nobuhiko Kuze,<sup>3</sup> Yoshihiro Sumiyoshi,<sup>4</sup> Koichi Tsukiyama,<sup>1</sup> Yasuki Endo<sup>5</sup>

<sup>1</sup> Department of Chemistry, Tokyo University of Science, Japan

<sup>2</sup> Department of Physics, College of Engineering, Nihon University, Japan

<sup>3</sup> Department of Materials and Life Science, Sophia University, Japan

<sup>4</sup> Division of Pure and Applied Science, Graduated School of Science and Technology,  
Gunma University, Japan

<sup>5</sup> Department of Applied Chemistry, National Chiao Tung University, Taiwan

Despite importance of the origin of life, long lasting challenges to detect the simplest amino acid glycine ( $\text{H}_2\text{NCH}_2\text{COOH}$ ) in interstellar medium has not been successful. As a preliminary step toward search for glycine, the detection of its precursor has received attention. It is considered that glycine is produced by a reaction of the HOCO radical and the aminomethyl radical ( $\text{CH}_2\text{NH}_2$ ) on interstellar grain surface [1]:



HOCO is produced by the reaction of  $\text{OH} + \text{CO} \rightarrow \text{HOCO}$ , and or  $\text{HCOOH} \rightarrow \text{HOCO} + \text{H}$ . However, HOCO and  $\text{CH}_2\text{NH}_2$  have not been investigated in interstellar medium. Recently, we determined the accurate molecular constants of HOCO [2]. Thus, accurate rest frequencies were derived from the constants. In the present study, we carried out the observations of HOCO in Sgr B2(M) with Nobeyama 45 m radio telescope, where Sgr B2(M) is a massive star-forming region and almost all reported interstellar molecules are observed in this region. Although HOCO could not be detected in Sgr B2(M) (Fig. 1), the upper limit of the column density was derived to be  $9.0 \times 10^{12} \text{ cm}^{-2}$  via the spectrum in the 88 GHz region by the rotational diagram method [3]. If the reaction (1) is main process of the glycine production in this region, the column density of glycine can be assumed to be comparable to that of HOCO [1]. This assumption allows us to derive the upper limit of column density of glycine which is one or two order smaller than the reported ones [4-8].

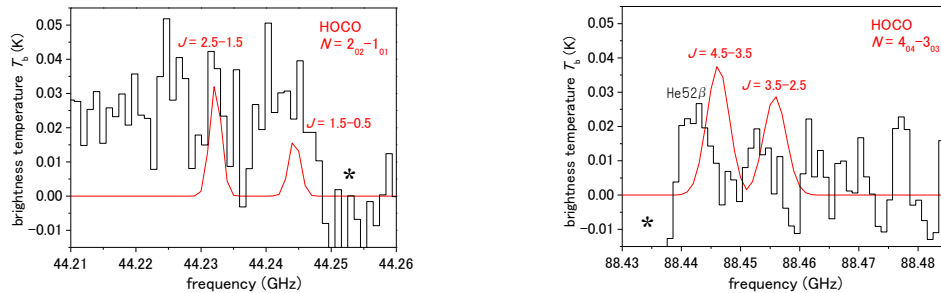


Fig. 1. The estimated lines of the  $J = 2.5-1.5$ ,  $1.5-0.5$ ,  $4.5-3.5$  and  $3.5-2.5$  transitions (red), and the observational results (black). The dips labeled by asterisks are absorption feature. Total ON times are 1.0 and 4.0 hours in the 44 and 88 GHz regions, respectively.

**References** [1] Woon *et al.*, *ApJ*, **571**, L177 (2002). [2] Oyama *et al.*, *JCP*, **134**, 174303 (2011). [3] Turner *et al.*, *ApJS*, **76**, 617 (1991). [4] Belloche *et al.*, *A&A* **482**, 179 (2008). [5] Jones *et al.*, *MNRAS*, **374**, 579 (2007). [6] Kuan *et al.*, *ApJS*, **593**, 848 (2003). [7] Cunningham *et al.*, *MNRAS*, **376**, 1201 (2007). [8] Brown *et al.*, *MNRAS*, **186**, 5 (1979).