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# グリシン前駆体 $CH_3NH_2$ の推定存在量
# Estimated Abundances of a Precursor of Glycine, $CH_3NH_2$

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In is widely accepted that prebiotic chemical evolution from small to large and complex molecules would have resulted in the Origin of Life. On the other hands there have been conflicting two views regarding where inorganic formation of organic molecules (hereafter OMs) occurred in the early Earth, in the Earth or out of the Earth. Ehrenfreund et al. (2002) indicated that exogenous delivery of OMs to the early Earth could be larger than their terrestrial formation by three orders of magnitude. If amino acids are formed in interstellar clouds, significant amount of them may be delivered by comets and/or asteroids to (extra-solar) planets. Detection of amino acids would accelerate the discussion concerning the universality of “life”.

So far, many trials to detect simplest amino acid, glycine ($CH_2NH_2COOH$), were made towards Sgr B2 and other high-mass forming regions, but none of them were successful due to insufficient sensitivities and spatial resolution of telescopes. This is the background that detection of amino acids and other prebiotic in the Universe is one of the key science targets for ALMA. However we need to have carefully selected good candidate sources for amino acids before conducting searches for amino acids by ALMA since lines could be contaminated by other molecular lines. One idea would be to survey precursors of amino acids; higher abundances sources of precursors would be amino acid rich sources.

Although the chemical evolution of interstellar N-bearing OMs is poorly known, methylamine ($CH_3NH_2$) is proposed as a precursor to glycine; theoretical and laboratory studies have indicated that glycine is formed on icy grain surface from methylamine and $CO_2$ through UV irradiation (Holtom et al. ApJ, 626, 940 (2005), Kim and Kaiser et al., ApJ, 729:68 (2011)). These studies also suggest that methylamine can be formed from abundant species, $CH_4$ and $NH_3$, on icy dust surface. Although $CO_2$ is widely known in molecular clouds, distribution of methylamine is poorly known. Further methylene imine ($CH_2NH$) would be related to $CH_3NH_2$. These species are thought to be formed through hydrogenation (addition of hydrogen) to HCN on dust surface (Dickens et al., 1997, Kim and Kaiser et al. 2011): HCN -> $CH_2NH$ -> $CH_3NH_2$. This is similar to the hydrogenation of CO to form $CH_3OH$: CO -> $H_2CO$ -> $CH_3OH$.

The first detection of methylamine was made by Kaifu et al. (1974). But even now, $CH_3NH_2$ is known toward two objects (Orion KL and Sgr B2) only. $CH_2NH$ has been reported only in Sgr B2, W51, Orion KL, and G34.3 (Dickens et al.1997).

Therefore it would be crucial to estimate abundances of $CH_3NH_2$ and $CH_2NH$ by using a chemical reaction network, which may be compared with observations. In this paper we present preliminary results of estimated abundances of these species, which would provide good guidance in finding good glycine sources and in understanding poorly known chemistry of N-bearing organic molecules in the Universe.

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