

## Chemical Properties of Glycine rich sources

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It is thought that early terrestrial life originated through chemical evolutions of organic compounds on the primordial Earth surface. Some organic molecules would be included in this process. However, it is still unknown if such organic molecules were formed on the Earth surface. Ehrenfreund et al. (2002) estimated that comets would have delivered sufficient amounts of organic molecules to the Earth surface. If this is a case, organic molecules, such as amino acids, would exist in the extraterrestrial environment. The simplest amino acid, glycine attracted attention of many scientists. Since glycine is detected in the comet (Altwegg 2016), it must contributed to the Early Earth chemistry to form the very first life. In these days, the latest telescope, ALMA, is expected to achieve the first detection of glycine. However, the formation process of glycine is poorly known. It would be essential to reveal which sources are promising glycine sources for the future glycine surveys.

The essential formation process of glycine was investigated by our modelling. For the chemical processes, in addition to the reaction dataset of KIDA, gas phase and grain surface formation processes of COMs by Garrod (2013) are included. We assumed that the physical evolution of star-forming regions start from the extended and cold gas. After the formation of the dense core, the gas and dust temperatures were raised to release the frozen species on the grain surface. With this model, we succeeded to explain almost observed COMs towards G10.47+0.03 (not only CH<sub>3</sub>OH, CH<sub>3</sub>OCH<sub>3</sub>, HCOOCH<sub>3</sub>, CH<sub>3</sub>COCH<sub>3</sub>, but also N-bearing species such as NH<sub>2</sub>CHO, CH<sub>2</sub>CHCN, CH<sub>3</sub>NH<sub>2</sub>, and CH<sub>2</sub>NH).

We confirmed that the radical-radical reaction of HOCO + CH<sub>2</sub>NH<sub>2</sub> is the most efficient formation process to glycine. These radicals are formed via the hydrogen subtraction process from HCOOH and CH<sub>3</sub>NH<sub>2</sub> by other radical species. For the formation process of CH<sub>3</sub>NH<sub>2</sub>, we reached to the same conclusion with Theule et al.(2011): the hydrogenation process to HCN is so rapid that almost HCN and CH<sub>2</sub>NH are converted to CH<sub>3</sub>NH<sub>2</sub>. While CH<sub>2</sub>NH is suggested as the precursor of CH<sub>3</sub>NH<sub>2</sub>, it is formed via the reaction of “NH + CH<sub>3</sub>” in the gas phase, and do not directly connected to CH<sub>3</sub>NH<sub>2</sub>. In the symposium, we will discuss the chemical properties of promising glycine rich sources from our modelling.

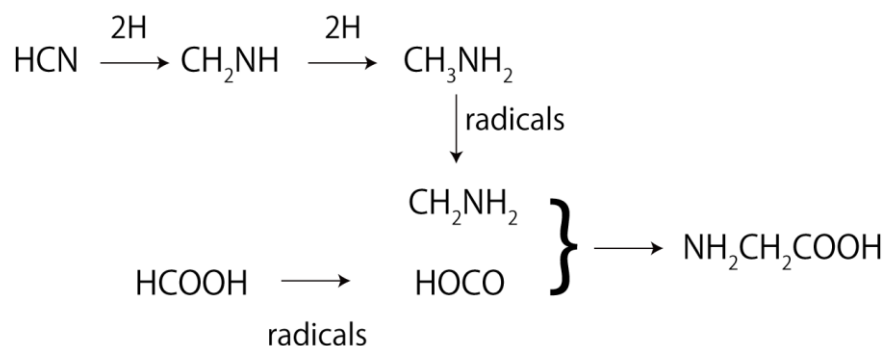


Figure1: Essential formation path to glycine

### References

- [1] Ehrenfreund, P., et al., 2002, Rep. Prog. Phys. 65, 1427
- [2] Altwegg, K., et al, 2016, science, 2, id=e1600285
- [3] Garrod, R, T., 2013, ApJ,765, 60