Non-energetic, Low-Temperature Formation of C_α-Glycyl Radical, a Potential Interstellar Precursor of Natural Amino Acids

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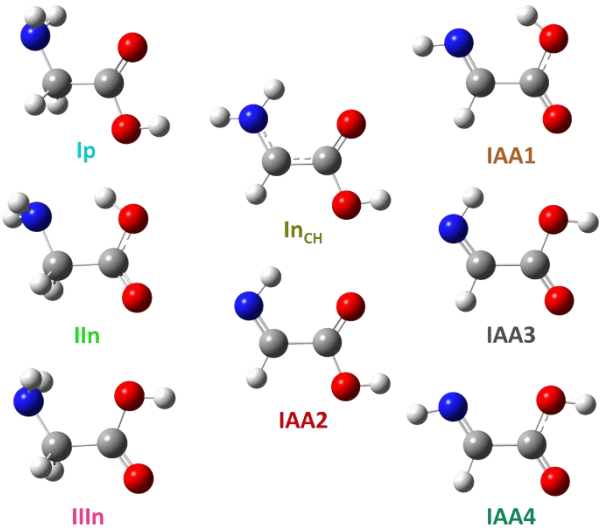
The reaction of glycine with H atoms was investigated in a solid *para*-H_2 matrix.[1] The reaction was followed by Fourier transform infrared (FTIR) spectroscopy. To support the experimental results and help the spectral analysis, quantum chemical computations were performed.

First, glycine was deposited in a *para*-H_2 matrix at 3.1 K, and its three conformers, Ip, IIn, and IIIn were identified. Then H atoms were generated in the matrix. Regardless of the distribution of glycine conformers, C_α-glycyl radical was formed in an H-atom-abstraction process with great selectivity, and in a smaller amount the product of the second H-atom-abstraction, the IAA2 conformer of iminoacetic acid was also detected. Finally, the effect of UV irradiation on the C_α-glycyl radical was investigated. The radical is sensitive to 280 nm light, its decomposition results in the formation of different conformers of iminoacetic acid (IAA1, IAA2, IAA3, and IAA4).



These results prove that C_α-glycyl radical can be formed from glycine in conditions relevant to dense molecular clouds. Combining this result with those of Ioppolo et al.[2] and Joshi et al.,[3] who have shown that glycine can be formed in the presence of H atoms in a non-energetic mechanism in dark clouds, we conclude that from glycine, natural α-amino acids can also be synthetized in a similar way in the solid phase of ISM. We are currently working on the experimental demonstration that serine can be formed by the recombination of C_α-glycyl and hydroxymethyl (·CH_2OH) radicals.

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[1] Schneiker, A.; Góbi, S.; Joshi, P. R.; Bazsó, G.; Lee, Y.-P. and Tarczay, G. Non-Energetic, Low-Temperature Formation of C_α-Glycyl Radical, a Potential Interstellar Precursor of Natural Amino Acids. *J. Phys. Chem. Lett.* **2021**, *12*, 6744−6751.
[2] Ioppolo, S.; Fedoseev, G.; Chuang, K.-J.; Cuppen, H. M.; Clements, A. R.; Jin, M.; Garrod, R. T.; Qasim, D.; Kofman, V.; van Dishoeck, E. F.; Linnartz, H. A Non-Energetic Mechanism for Glycine Formation in the Interstellar Medium. *Nat. Astron.* **2021**, *5*, 197–205.
[3] Joshi, P. R.; How, K. C.-Y.; Lee, Y.-P. Hydrogen Abstraction of Acetic Acid by Hydrogen Atom to Form Carboxymethyl Radical •$CH_2C(O)OH$ in Solid *para*-Hydrogen and Its Implication in Astrochemistry. *ACS Earth Space Chem.* **2021**, *5*, 106–117.