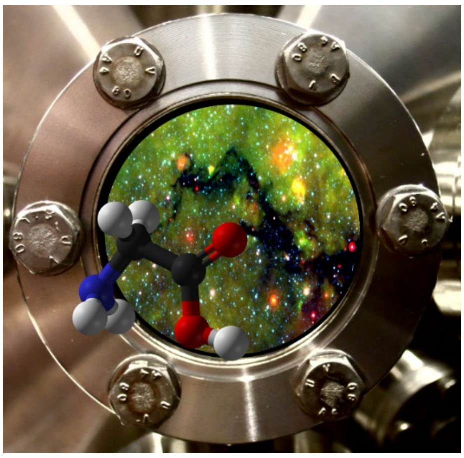
Annual Highlights

Researchers within INTERCAT have shown that glycine the simplest amino acid and an important building block of life, can form under the harsh conditions that govern chemistry in space. The results, published in Nature Astronomy,[1] show that glycine and very likely other amino acids are formed in dense interstellar clouds, well before these transform into new stars and planets.

Comets are the most pristine material in our Solar System and reflect the molecular composition at the time our Sun and planets were just about to form from material chemically processed in the interstellar medium. The detection of glycine in the coma of comet 67P/Churyumov-Gerasimenko and in samples returned to Earth from the Stardust mission strongly hint at a prestellar origin of amino acids. Until recently, glycine formation was thought to occur through energetic radiation, setting clear constraints on the environment in which it can be formed. These new results show that it is possible to form glycine on the surface of icy dust grains through 'dark chemistry'.

"Dark chemistry" describes chemical process in the Interstellar Medium that do not require energetic radiation in order to proceed. In the Laboratory for Astrophysics at Leiden Univeristy, researchers simulated the conditions found in dark interstellar clouds, where dust particles are cooled to 10-20 K and are covered by thin layers of abundant ices - frozen CO, NH_3, CH_4 and H_2O. These molecular films were subsequently processed through interaction with atomic beams, causing the precursor species to fragment and reactive intermediates to recombine. Both methylamine, a chemical precursor to glycine detected in the coma of the comet 67P, and glycine itself were shown to form. The experiments used a unique ultra-high vacuum setup, equipped with a series of atomic beam lines, infrared spectroscopy and mass spectrometry tools.

The experiments were performed under fully controlled laboratory conditions and show that a non-energetic surface formation path for glycine at low temperatures is possible, different from previous work that required UV radiation to produce this molecule. Astrochemical models support the findings and allow for extrapolation of data obtained on a typical laboratory timescale of just one day, to interstellar conditions, bridging millions of years.



Laboratory experiments demonstrate that glycine, the simplest amino acid, can be formed under conditions that are typical for those regions in interstellar space where new stars and planetary systems form.

INTERCAT
Center for Interstellar Catalysis

[1] A non-energetic mechanism for glycine formation in the interstellar medium
S. Ioppolo, G. Fedoseev, K.-J. Chuang, H.M. Cuppen, A.R. Clements, M. Jin, R.T. Garrod, D. Qasim, V. Kofman, E.F. van Dishoeck, and H. Linnartz; Nature Astronomy, DOI number 10.1038/s41550-020-01249-0.