

Interstellar Origin of Complex Molecules Detected in Meteorites: Experimental Evidence from Irradiated Ices

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In the coldest regions of molecular clouds, interstellar dust grains are covered with layers of ice composed mainly of simple volatile molecules. Exposure to secondary UV photons and subsequent heating in regions such as hot cores induce increasing chemical complexity in these ices. The resulting organic matter evolves from molecular clouds to protoplanetary discs, contributing to the formation of Solar System bodies, such as primitive chondritic material and, ultimately, planets.

Laboratory experiments are fundamental to understanding the origin and evolution of this organic matter. In this work [1], we performed UV irradiation followed by warming to room temperature of H₂O:CH₃OH:NH₃ ice mixtures deposited at 80 K. Some of the products generated are stable at room temperature and form a refractory organic residue rich in organic compounds, many of which are of astrobiological interest.

Using gas chromatography coupled with mass spectrometry (GC-MS), we have identified relevant compounds, including new derivatives of hexamethylenetetramine (HMT, (CH₂)₆N₄) and five-membered nitrogen heterocycles. Some of these compounds have already been detected in comets and meteorites [2], reinforcing the hypothesis of their interstellar origin. In addition, the detailed mass spectra we present open up new possibilities for the identification of HMT-based molecules in pristine materials from the Solar System.

References

- [1] C. del Burgo Olivares, et al., 2025, A&A, 698, A285.
- [2] Y. Oba, et al. 2020, Nature Communications, 11, 6234