



Contribution ID : 46

Type : Oral

The structure and spectroscopy of solid propanal: A potential mineral for planetary astrobiology

Wednesday, 24 November 2021 15:50 (15)

Aldehydes are considered an important species toward astrobiology, acting as a primary reagent for the Strecker synthesis of amino acids in aqueous media. However, within the cold, icy surfaces of planetary bodies and interstellar dust particles, chemical reactions that lead to these biological-building blocks can still unfold. Here, “non-thermal equilibrium” chemistry is driven by harsh radiation environments, which produce populations of radicals and charged species in the icy matrix. It is these short-lived intermediates that then on-react with ammonia and cyanides to form higher-order organics.

For the possible detection of proteinogenic amino acids in space environments it is important to first locate their more abundant amino acid precursors. However, only formaldehyde and acetaldehyde has been observed by telescope and spacecraft reconnaissance to date. The search for other simple aldehydes has been hampered by a general lack of fundamental data including crystal structure and spectroscopic signatures.

In a combined neutron scattering (ANSTO Wombat Instrument) and x-ray diffraction study, we have determined the crystal structure of propanal ($\text{CH}_3\text{CH}_2\text{CHO}$)-under planetary ice surface conditions-for the first time. This new structure allowed for the DFT simulation of its vibrational frequencies, which was then applied to assign its far-infrared spectrum collected at the Australian Synchrotron THz Beamline. This critical structural and spectroscopic data will enable the search for this species during future surveys and spacecraft exploration of distant icy worlds in our quest to uncover the molecular origins-of-life.

Level of Expertise

Expert

Presenter Gender

Man

Pronouns

He/Him

Which facility did you use for your research

Australian Centre for Neutron Scattering

Students Only - Are you interested in AINSE student funding

Do you wish to take part in the Student Poster Slam

Condition of submission

Yes

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Session Classification : Earth, Environment & Cultural Heritage

Track Classification : Earth, Environment & Cultural Heritage