Laboratory investigation of the physical and chemical properties of cosmic dust and ice in star forming regions

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Description:
The continuous cycle of star formation, evolution and death is driven by a complex interplay between interstellar gas, dust and radiation. Star formation begins in dense molecular clouds in the interstellar medium (ISM), where cold (~10 K) interstellar dust plays a crucial role in the chemical evolution. The microscopic silicate/carbonaceous dust particles:
(1) provide the surfaces for atoms and molecules to meet, react and form icy mantles constituting the largest molecular reservoirs in the ISM
(2) are responsible for extinction (by scattering and absorption) of intense stellar radiation at the edges of dense molecular clouds, enabling chemicals to survive deeper in their interior
(3) aggregate as a critical first step in the formation of planetary systems like our Solar System.

Most of what we know about the properties of astrochemical ices comes from the direct comparison of astronomical data from infrared telescopes (ISO, Spitzer, AKARI) with spectroscopic laboratory data [Herbst, Chem Rev 113, 12, 2013]. However, these laboratory studies have almost exclusively been conducted by growing ices by vapour deposition onto large (cm-sized) flat substrates which are unrepresentative of interstellar dust material. This raises the key Astrochemistry question: are the physical and chemical properties of such bulk ices analogous to those of the ices covering microscopic 3D fractal-like particles found in the ISM?

In the OU Astrochemistry laboratories, we investigate the physical and chemical properties of astrochemical ices in a controlled laboratory environment using ultra-high vacuum chambers and cryogenically cooled substrates to grow interstellar ice analogues. As well as investigating such traditionally grown bulk ices, the successful candidate will be involved in the development of a new laboratory astrochemistry technique utilising acoustic levitation to suspend and trap realistic micro/nano-scale interstellar dust grain analogues and coat them with ice [Mason, Dawes, Faraday Disc 113, 311, 2006]. An experimental programme will be developed to investigate:
(1) the physical and chemical properties of the ices grown on such nano/micro-scale particles and compare to bulk ices
(2) the optical properties of bare and ice-coated dust
(3) the sticking an aggregation of the levitated icy particles within the trap
(4) compare lab results with observational infrared spectra
The successful candidate will have access to a variety of laboratory techniques to characterise and process the ices using in situ Fourier-Transform Infrared Spectroscopy (FTIR) on-site and Vacuum Ultraviolet (VUV) spectroscopy using synchrotron facilities (ASTRID2 in Aarhus, Denmark). Mass spectroscopy will be used to monitor species released into the gas phase during thermal and non-thermal ice processing. This laboratory data will be directly compared with astronomical observations made by other members of the OU Astrochemistry Group.

We seek an enthusiastic and highly motivated candidate with an interest in Astrochemistry and willingness to learn and develop laboratory techniques to acquire high quality laboratory data and to make direct comparisons between laboratory and observation. The successful candidate will work in a stimulating, nurturing research environment as part of an open, friendly and dynamic Astrochemistry group, consisting of PhD students, post-doctoral researchers (both laboratory and observational) and supported by world-class academics.

**Qualifications required:**

A First Class or Upper Second class MSci degree in Physics, Chemistry or related discipline. Any previous experience in vacuum technology and experimental techniques such as FTIR, UV-Vis and Mass Spectroscopy.