Laboratory Surface Science: The Key to the Gas-Grain Interaction

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It is widely recognised by the astronomical community that understanding the chemical processing of molecular gas clouds is the gateway to understanding key aspects of the physics of star formation [1] and, possibly, to understanding the origin of life itself. [2] Central to this is the recognition that physical and chemical processes occurring at the surfaces of interstellar grains are crucially important. Grains provide catalytic surfaces upon which a variety of reactions occur that are crucial to the chemical evolution of molecular clouds. They provide surfaces onto which gaseous molecules may condense and when irradiated by photons and cosmic rays are the chemical nanofactories in which the complex molecules of life may be synthesised from simple ices. Of course, the key to this chemistry is an appreciation of the role of the adsorption and desorption of atoms and molecules from the grains themselves, under both reactive and non- reactive conditions. It is with this insight that we have developed an interdisciplinary programme that brings together laboratory surface science with molecular astrophysics and astronomy in researching aspects of such interactions in our laboratory.

As part of this programme, we have developed a unique apparatus that is capable of investigating such chemistry under conditions of temperature and pressure that mimic those of the interstellar medium. [3] Using a combination of reflection-absorption infrared spectroscopy, mass spectrometric techniques and nanogravimetry, our studies to date have focussed on the adsorption and desorption behaviour of simple molecular species commonly observed in the interstellar medium under conditions where the simple physical processes dominate and chemical reactivity is negligible. We have demonstrated clearly to the astronomy community the effectiveness of such surface science methodologies in studies of water ice desorption [4] and the interaction of carbon monoxide with water ice surfaces. [5] In this presentation, we will present these results and make a more general case that if we are to fully understand the role of the gas-grain interaction, then we must employ surface science, its tools and methodologies to these studies.

References:

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