Reaction Dynamics in the Interstellar Medium - From Molecule Formation in the Gas Phase to Interstellar Grains

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The formation of molecules in extraterrestrial environments has fascinated scientists since the pioneering detection, in 1937-39, of CH, CH^+, and CN in interstellar space. We now know of at least 120 species, ranging in complexity from diatomics such as molecular hydrogen (H_2) to polyatomics like the sugar glycolaldehyde ($HOCH_2CHO$), benzene (C_6H_6), and cyanopentaacetylene ($HC_{11}N$), which have been identified as gas-phase constituents of extraterrestrial environments. Nevertheless, many facets of the question "How do these molecules arise?" remain unanswered or contentious. In searching for answers to this question, we also obtain crucial information relevant to the chemistry of our immediate environment: the rules of chemistry, after all, are universal, even when the conditions are very different.

This talk reviews recent developments on laboratory experiments to untangle how complex (astrobiologically important) molecules are formed in extraterrestrial ices (Solar System Ices, ices on interstellar grains) and in the gas phase (ISM, atmospheres of planets and their moons). The experimental techniques utilized are surface scattering experiments at UHV conditions ($< 5\times10^{-11}$ torr) and crossed molecular beam studies under single collision conditions. Implications to specific Solar System Environments like Kuiper Belt Objects and Saturn's satellite Titan are presented, too.

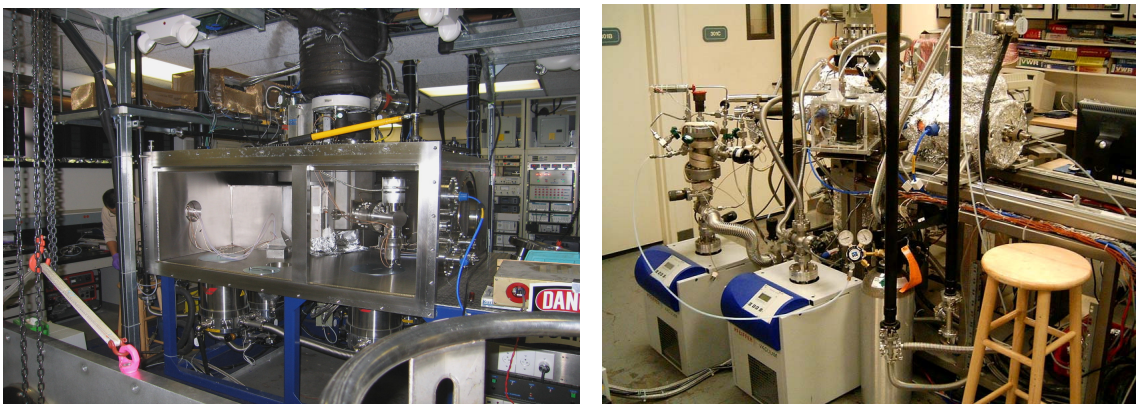

Figure 1: Images of the crossed molecular beams machine (left) and the surface scattering machine (right) utilized to study bimolecular neutral-neutral reactions in the gas phase and the interaction of ionizing radiation with (icy) surfaces.