Astrochemistry – The Final Frontier

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Over the last decade, ice-coated interstellar nanoparticles emerged as molecular factories in the synthesis of complex, often biorelevant organics in cold molecular clouds and in star-forming regions. An intimate understanding of the fundamental reaction mechanisms generating these nanoparticles along with complex organics on their surfaces in deep space requires new knowledge not only on fundamental gas-phase reaction pathways to carbonaceous nanostructures, but also on the processing of low temperature ices by (non)ionizing radiation present even deep inside cold molecular clouds.

This talk provides an overview on recent advances in gas phase molecular beams studies and novel surface science experiments of particular importance to the formation of astrobiologically important molecules within interstellar ices. These studies are aimed to decipher the underlying reaction dynamics and kinetics leading to polycyclic aromatic hydrocarbons (PAHs) as fundamental molecular building blocks and precursors to carbonaceous nanoparticles (gas phase) [1-4] and to complex organics (surface science) in deep space [5-8], many of which should not exist according to classical textbook knowledge. Novel developments focus on isomer selective vacuum ultraviolet photoionization (PI) techniques coupled with reflectron time-of-flight mass spectrometry (ReTOF-MS) exploiting single photon ionization in combination with the detection of functional groups via infrared spectroscopy (FTIR) with vacuum ultraviolet light generated by four-wave mixing and from synchrotrons. Facile low-temperature routes to complex aromatics signify a fundamental shift in the perception that aromatics can be only formed under high-temperature conditions on electronic ground state surfaces with novel mechanisms comprising excited state dynamics, submerged barriers, and unconventional concerted reactions between aromatic radicals.

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