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Ice chemistry apparatus with a fast-tuning 7.5 ÷ 11.5 eV vacuum ultraviolet source for processing and detection

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Solid phase processes contribute to the chemical evolution in interstellar and circumstellar media via interactions between icy grains mantles and dissociative and ionizing radiation. Such energetic processing of ices affects the ice composition via non-equilibrium surface desorption processes and chemical reactions throughout the ice. Far ultraviolet radiation is a potentially important source of this processing in many different astrophysical environments. In order to study the detailed kinetics and mechanisms of photon-induced ice desorption and chemistry we have constructed a new astrochemistry laboratory apparatus featuring a laser-based vacuum ultraviolet (VUV) source and a cryo-cooled target in an ultra-high vacuum environment. The tunable VUV source is also used for the selective single-photon ionization coupled with reflectron time-of-flight mass spectroscopy. In parallel, infrared spectroscopic characterization is implemented in both transmission and reflection modes.
The proposed astrochemical studies include tunable wavelength photodesorption, monochromatic processing of ice mixtures, and ionization energy selective mass-spectroscopic detection of complex organics formed in energetically processed ice mixtures of astrophysical relevance. The latter is particularly useful for isomer-specific studies which reveal finer details of chemical processes in the processed ices. Our system's rapid VUV tunability in 7.5 ÷ 11.5 eV range eliminates variations associated with a set of separate experiments at fixed distinct wavelengths, significantly advancing the state of the art in laboratory astrochemistry.
We are presenting the current state of the setup, the laser sub-system's characteristics, as well as initial experimental results demonstrating its sensitivity and selectivity. We discuss its development and projected research capabilities.

Summary

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