NEW PHYSICAL AND CHEMICAL PROCESSES IN CRYOGENIC WATER-ICES CAUSED BY EASY IONIZATION OF EMBEDDED ORGANIC IMPURITIES: ASTROPHYSICAL AND ATMOSPHERIC IMPLICATIONS

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Water-rich, mixed molecular ices are common throughout interstellar molecular clouds, the Solar System, and atmospheric aerosols. Laboratory analog experiments have shown vacuum ultraviolet (VUV) irradiation and particle bombardment of water dominated mixed molecular ices containing impurities such as CH_3OH, NH_3, CO and PAHs (polycyclic aromatic hydrocarbons) produce complex organic species, including important biogenic molecules such as amino acids and functionalized PAHs which may have played a role in the origin of life.In an attempt to understand the fundamental processes that occur during VUV photolysis of water dominated mixed molecular ices containing organic (PAH) impurities, several new phenomena were recently discovered in our laboratory that enhance our understanding of the physics and chemistry of low-temperature water-rich ices. (a) PAHs embedded in cryogenic water ice are easily and efficiently ionized with close to 80% conversion (i.e., near quantitative photoionization yields) to the PAH-cations by VUV photons; (b) PAH ionization energy is lowered by up to 2 eV comparedto the gas-phase, in agreement with recent theoretical predictions; (c) PAH cations are stabilized to temperatures as high as 120 K; and (d) Multiple ionization and stabilization of large aromatic molecules such as quaterrylene (QTR) to QTR^{++} occurs readily in water ice.
These results and the corresponding new optical spectroscopy of water-ices will be presented.

References

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