Electron and Ion Radiation Processes on Astrophysical Ice Surfaces: Development of a New Experimental Facility at SINP, Kolkata, India

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Understanding the processes induced by electrons and ions on surfaces is a fascinating area of study within atomic and molecular physics. Astrophysical environments are immersed in high-energy electron and ion radiation. For example, cosmic rays (MeV to GeV) and local stellar radiation irradiate interstellar dust clouds; solar wind, low-energy (keV) electrons, and protons bombard solar system bodies; Jupiter' s and Saturn's local magnetospheric trapped energetic particles such as H+, O+, S+, and He+ with keV to MeV energies are constantly bombarding Jupiter and Saturn's moons. Therefore, understanding the radiation processes on astrophysical dust ice and planetary surfaces at extreme conditions is necessary. However, studying ion- and electron-induced processes at particularly low temperatures presents unique experimental challenges such as maintaining interstellar conditions in a laboratory environment. These studies also aim to understand the origin of prebiotic species and their evolution from dense molecular clouds to planetary systems via protoplanetary disks. The primary objective of the laboratory is to explore the electron- and ion-induced processes on astrophysical dust ice surfaces to understand physical processes such as sputtering of surface species and modifications of surface species during radiation processes in the context of fundamental molecular physics, astrophysics, and planetary science. This will be studied using mass spectrometry and near- to mid-infrared spectroscopy during electron and ion irradiation, as well as during the warming of the sample using temperature-programmed desorption following electron and ion bombardment. Currently, at SINP, I am establishing the APRIS Laboratory —Astrophysical and Planetary Radiation-Ice Surface Laboratory. This will be a state-of-the-art laboratory dedicated to investigating electron- and ion-induced processes on astrophysical ices. The laboratory will provide a platform for studying fundamental physical processes under space-relevant conditions and will contribute to different areas of space science, including astrophysics and planetary science. In this presentation, I will discuss the current development of the APRIS Laboratory and its potential contributions to India's space missions, particularly ISRO missions, as well as to international space missions, including missions led by NASA and ESA.

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