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Low energy singly and multiply charged ion irradiation of astrophysical ices

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Abstract.
Ion induced processes play an important role in the chemical modification of astrophysical ices, both on the surfaces of satellites in the outer solar system and in the depths of dark molecular clouds where few photons penetrate. To date many laboratory studies have been developed to study energetic singly charged ion interactions with astrophysical ice analogues (e.g. (Mennella, et al(2004)), (Strazzulla, Baratta & Palumbo (2001)), (Gerakines, Moore, & Hudson (2000)) and have been found to produce new chemical species and cause significant effects on ice morphology (Palumbo (2005)). However, the effects of low energy and multiply charged ions have not yet been investigated. Such ions are prevalent in many astrophysical environments: as primary and secondary particles generated by cosmic ray bombardment and as constituents of planetary magnetospheres (e.g. Jupiter and Saturn). These ions comprise a rich variety of reactive species in a variety of charge states with typical kinetic energies of few keV. The effect of slow, multiply charged ions (MCIs) with the surfaces of astrophysical ices and their possible effect on chemical processing is unclear. However, studies of MCI impacts with insulator surfaces suggest that they may play an important role due to surplus potential energy imparted at the surface of the target (Winter & Aumayr (2001)).

We have developed a research program to study ion interactions with astrophysical ices using an Electron Cyclotron Resonance (ECR) ion source at Queens University Belfast. Such a source can produce different species of ions with variable energy and different charge states. Ices are prepared in situ by depositing gas onto a cold infrared transmitting window. Samples are analysed using FTIR spectroscopy during irradiation. We have conducted a series of experiments to investigate the effects of ion charge state (potential vs. kinetic energy effects), ion energy (nuclear vs. electronic stopping processes) and sample temperature. In this poster we present the results of irradiation of low and high temperature H_2O ice films with C^{n+} (n = 1, 2, 4) ions at 2 - 4 keV. The significance of the results will be discussed and possible reaction pathways for the formation of new products (CO and CO_2) proposed.

Keywords. astrochemistry, molecular processes, planets and satellites: general, ISM: molecules, cosmic rays

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