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A combined experimental and theoretical study on the charged particle processing of low temperature ices

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Abstract. Non-equilibrium chemistry is of considerable importance when studying a number of different astronomical objects ranging from interstellar dust in molecular clouds to icy bodies within our solar system (icy planets/satellites, comets, Kuiper belt objects). Each of these environments is subject to varying amounts of irradiation from three main components: photons (UV), ions (predominantly H^+ and He^{2+}), and electrons. We have designed a surface scattering machine capable of studying the irradiation effects of high energy photons and particles with solid ices enabling the conditions appropriate to solar system bodies as well as interstellar ices to be simulated. Presented are the latest results from the irradiation of pure and binary mixtures of ices after irradiation with energetic electrons (O_2, CH_4, CH_3OH, CH_4/CO_2, CH_3OH/CO), highlighting molecules created with astrobiological significance. The use of electrons to irradiate the ices serves not only to replicate the effects of electrons interacting with ices (from solar winds or magnetospheres), but it also simulates the chemical modification caused by delta-electrons produced during ion bombardment and in fact also has comparable linear energy transfer as it passes through the ice to an MeV proton enabling us to simulate these elastic energy transfer processes without the use of a cyclotron required to generate these high energy particles.

Keywords. astrochemistry, molecular processes, methods: laboratory, ISM: lines and bands, infrared: ISM, infrared: solar system