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Laboratory analogues to simulate the irradiation of icy surfaces of Jupiter's moons and other icy objects in the solar system

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The surfaces of Jupiter's icy moons are continually irradiated by charged particles from the Jovian plasma environment. This irradiation triggers chemical reactions in the surface ice and also acts as an atmospheric release process. Remote observations, theoretical modelling, and laboratory experiments must be combined to understand this plasma-ice interaction.

Over the last years, we experimented with a wide variety of water ice samples in vacuum conditions, ranging from dense ice films (100 nm) on microbalances to thick (1 cm) and porous ice regolith. We subjected these ice samples to electron and ion irradiation and quantified the sputtering yields and other loss processes. Now we shifted our attention to studying the chemical and physical alterations in ice samples upon long-term irradiation. We monitor these alterations with spectral cameras in the visible and near-infrared wavelength range and with a new dedicated time-of-flight mass spectrometer.

A new experimental result with potential application to icy moons and comets concerns the radiolysis of H_2O ice to H_2 and O_2 upon irradiation. Our preliminary analysis indicates that electron irradiation of thick regolith ice samples leads to the formation of an irradiated water ice layer with an O_2/H_2O ratio of 1-2%. This is the same order of magnitude as the O_2 abundance inferred from surface reflectance spectra for Ganymede [Calvin et al. 1996], Europa, and Callisto as well as from ROSINA measurements for 67P/Churyumov-Gerasimenko [Bieler et al. 2015].