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Europa's Ice-Related Atmosphere: The Sputter Contribution

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Europa, Jupiter's innermost icy satellite, is embedded well within Jupiter's magnetospheric plasma, an intense flux of ions and electrons that approximately co-rotate with Jupiter. With Jupiter's rotation period being substantially shorter than Europa's orbital period, the Jovian plasma constantly flows over Europa from its trailing hemisphere and sweeps ahead of it on its orbital motion. The plasma itself can be though of as consisting of two populations: the cold, thermal plasma with energies ranging from eV to keV and the hot, energetic plasma with energies ranging from keV to MeV. As the plasma encounters Europa's icy surface, two processes are induced: radiolysis, where the ice is physically and chemically altered, and sputtering, where surface material is liberated from the ice matrix to form a tenuous atmosphere.

In this work we analyse the sputter contribution of Europa's icy surface to its exosphere, and show that both the cold, thermal plasma as well as the hot, energetic plasma are of importance. Our modelling results are based on first principle, that is no scaling to surface fluxes or observed densities are applied. Instead, we apply current knowledge of Jupiter's plasma properties, as well as most recent lab results on ice sputter yields to our Monte Carlo model, to model Europa's exosphere ab initio. Worth mentioning is that this work is the first to incorporate lab measurements of electron ice sputter yields in an Europa model. Similarly to previous modelling results, our simulations show that Europa's exosphere is dominated by a bound, thermalized O_2 atmosphere close to the surface (below $\sim$1000 km), and by an extended corona of light H2 molecules at higher altitudes.