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Analytical model of Europa's O_2 exosphere

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The origin of the exosphere of Europa is its water ice surface. The existing exosphere models, assuming either a collisionless environment (simple Monte Carlo techniques) or a kinetic approach (Direct Monte Carlo Method) both predict that the major constituent of the exosphere is molecular oxygen. Specifically, O_2 is generated at the surface through radiolysis and chemical interactions of the water dissociation products. The non-escaping O_2 molecules circulate around the moon impacting the surface several times, due to their long lifetime and due to their non- sticking, suffering thermalization to the surface temperature after each impact. In fact, the HST observations of the O emission lines have manifested the presence of an asymmetric atomic Oxygen envelope, evidencing the possible existence of a thin asymmetric molecular Oxygen atmosphere. The existing Monte Carlo models are not easily applicable as input of simulations devoted to the study of the plasma interactions with the moon. On the other hand, the simple exponential density profiles cannot well depict the higher temperature/higher altitudes component originating by radiolysis. On the contrary, it would be important to have a suitable and user-friendly model to use as a tool.
This study presents an analytical 3D model that is able to describe the molecular Oxygen exosphere by reproducing the asymmetries due to two configurations among Europa, Jupiter and the Sun, that is illumination at leading and at trailing side. This model is obtained by a non-linear fit procedure of the EGEON Monte Carlo model to a Chamberlain density profile. Different parameters of the model are able to describe various exosphere properties thus allowing a detailed investigation of the exospheric characteristics.