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Sputtering at Ganymede – What about ionospheric ions?

Gianluca Carnielli (1), Marina Galand (1), Ronan Modolo (2), François Leblanc (3), Ludivine Leclercq (4), and Arnaud Beth (1)

(1) Imperial College London, Physics, London, United Kingdom (gc210@ic.ac.uk), (2) LATMOS/IPSL, UVSQ Université Paris-Saclay, UPMC Univ. Paris 06, Guyancourt, France, (3) LATMOS/CNRS, UPMC Univ. Paris 06 Sorbonne Universités, UVSQ, Paris, France , (4) University of Virginia, Charlottesville, Virginia, US

Ganymede's neutral exosphere is currently expected to be generated mainly from two physical processes: sublimation in the subsolar region from solar radiation and surface sputtering from the bombardment of energetic ions. The latter process has a large degree of uncertainty in relation to the poor constraints on the spatial and energetic distribution of the sputtering sources. These include ions from the Jovian magnetosphere and from Ganymede's ionosphere. Sputtering from Jovian ions has been previously estimated (e.g., Ip et al. [1997], Paranicas et al. [1999]), while the contribution from ionospheric ions has never been assessed and has been neglected so far.

Using a 3D test particle ionospheric model developed specifically for Ganymede (Carnielli et al., submitted), we calculated the contribution to the sputtering rate from ionospheric ions. Furthermore, by adapting the model to incorporate the Jovian ions we made new estimates of the contribution to sputtering from the Jovian source, considering the thermal population (H+ and O+ in the keV range, Kivelson et al. [2004]) and the energetic population (H+, O++ and S+++ in the keV – MeV range, Mauk et al. [2004]).

We will present the results of our simulations, including: surface maps of the different impacting species, the sputtering rate contribution from each species (and from each energy range considered for the case of the Jovian energetic population) and the variation of the location of impact and the sputtering rates as Ganymede orbits around Jupiter.
The results of our simulations suggest that the sputtering rate from ionospheric ions is comparable to that from Jovian ions, and that the process occurs primarily in the equatorial region, which was previously considered to be shielded from sputtering due to closed magnetic field lines acting as a barrier for the Jovian magnetospheric ions. However, this consideration did not take into account ionospheric ions as well as very energetic magnetospheric ions which are able to penetrate in the equatorial region, as found by our simulations.

We will discuss the implications that our results have on exospheric models of Ganymede and on the ionospheric model that we used.