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Hybrid MHD simulation of the coupling between Ganymede's magnetosphere and its ionosphere

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Ganymede was found to generate its own magnetosphere, embedded inside that of Jupiter and shaped by the interaction between its internal dipole (Kivelson et al. [1996]) and the permanent flow of sub-sonic and sub-Alfvénic Jovian magnetospheric plasma.

To date, many features of Ganymede's magnetosphere remain poorly understood due to the limited amount of in-situ data that we received from Galileo. In particular, we are not able to describe how Ganymede's ionosphere couples to the surrounding magnetosphere.

Previously, we developed a 3D test particle model for Ganymede's ionosphere (Carnielli et al., submitted) in which we created ionospheric particles from ionization of exospheric neutrals by solar EUV radiation and by Jovian magnetospheric electrons. The ionospheric model was based on a pre-defined configuration of the electric and magnetic fields (from the magnetospheric hybrid model of Leclercq et al. (2016)) and of the neutral exosphere (from the exospheric model of Leblanc et al. (2017)). We obtained 3D maps of the number density, bulk velocity and temperature for the different ion species which are anticipated to be present in Ganymede's ionosphere. The drawback of this model is that it is not self-consistent, namely the ionospheric particles do not influence the electric and magnetic fields, which stay constant throughout the simulation.
To take a step further, we coupled the test particle model with the magnetospheric hybrid model of Leclercq et al. (2016). The ionosphere in the coupled simulation is generated from the same physical sources, and the previous assumption of spherical symmetry used by Leclercq et al. (2016) is removed, allowing a more realistic simulation of both the ionosphere and the magnetosphere.
We will discuss the outcome of the coupled simulations. After explaining how we carried out the coupling, we will show how the coupled model results differ from the original model in which a spherically symmetric ionosphere was assumed and an educated guess for the density profile of the ionospheric species was made.

The results from the coupled model will be relevant for the JUICE mission for the interpretation of magnetic signatures found by the J-MAG instrument and to decouple them from signatures of the sub-surface ocean. Comparison between the coupled model simulation and plasma and particle observations from close Galileo flybys will be presented.