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Constraining Ganymede's exosphere through numerical simulations of its ionosphere and Galileo observations

Gianluca Carnielli (1), Marina Galand (1), Ronan Modolo (2), François Leblanc (3), Arnaud Beth (1), Hans L. F. Huybrighs (4,5,6), Xianzhe Jia (7)
(1) Department of Physics, Prince Consort Road, Imperial College London, London SW7 2AZ, UK (gianluca.carnielli10@imperial.ac.uk), (2) LATMOS/IPSL, UVSQ Université Paris-Saclay, UPMC Univ. Paris 06, Guyancourt, France, (3) LATMOS/IPSL, CNRS, Sorbonne Université, UVSQ, Paris, France (4) Max-Planck-Institut für Sonnensystemforschung, Göttingen, Germany, (5) Swedish Institute of Space Physics, Post Office Box 812, Kiruna, Sweden, (6) Institut für Geophysik und extraterrestrische Physik, Technische Universität, Germany, (7) Department of Climate and Space Sciences and Engineering, University of Michigan, Ann Arbor, MI 48109-2143, USA

Abstract

Our current understanding of Ganymede's neutral environment derives from models which are driven by a limited set of observations. These include remote sensing UV measurements from close flybys by the Galileo and Voyager spacecraft and from Earth by the Hubble Space Telescope (HST).

Estimated parameters from observations include the column density of H [1,2] and O_2 [2,3]. For O_2, we argue that the derivation of the column density was based on strong assumptions on the plasma environment, which is poorly characterized. These estimates have been used as reference values in exospheric models (e.g. [4,5,6]), but cannot be confirmed without additional in situ measurements, which will be made by the JUICE spacecraft during the late phase of the mission.

One way to check the consistency between the estimated column density of the neutral species and Galileo observations, is to develop a model of Ganymede's ionosphere, starting from an exosphere which reproduces the estimated column densities, and check that the plasma properties derived by the model along the flyby trajectories correspond to those measured by Galileo.

We have developed such a model for Ganymede [7] using the exospheric configuration from Leblanc et al. (2018) [4], which reproduces the O_2 column density estimated by Hall et al. (1998) [3]. For the plasma number density along the Galileo flyby trajectories, the model underestimates by more than one order of magnitude the observations. We attribute the cause of this discrepancy to the assumed configuration of the neutral exosphere, which we argue to be underestimated.

Here, we present a new possible configuration of the O_2 exosphere which leads to a plasma density in the ionospheric model that is consistent with that measured by Galileo along the close flyby trajectories. To reach agreement, we had to increase the column density of O_2 from the original estimate of Hall et al. (1998) [3].

We conclude that overall Ganymede's O_2 exosphere should be denser than what has been assumed so far.

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