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Energetic proton depletion near Io: atmospheric charge exchange and inhomogeneous magnetic and electric fields

Christiaan van Buchem^{1,2}, Hans Huybrighs¹, Aljona Blöcker³, Vincent Dols⁴, Olivier Witasse¹, and Yamila Miguel²

¹ESA, ESTEC, Noordwijk, Netherlands (christiaanvanbuchem@gmail.com)

²Leiden University, Leiden, the Netherlands

³KTH, Royal Institute of Technology, Stockholm, Sweden

⁴LASP, Laboratory of Atmospheric and Space Physics, Colorado, USA

The flux of energetic protons (80 keV-1.04 MeV) near the Galilean moons was measured by the Energetic Particle Detector (EPD) on the Galileo mission (1995 - 2003). Near Galilean moon, such as Io and Europa, depletions of the energetic proton flux, of several orders of magnitude, were observed.

Such energetic proton depletions can be caused by the precipitation of these particles onto the moon's surface or charge exchange with the neutral atmosphere. In order to interpret the depletion features in the EPD data, a Monte Carlo particle tracing code has been developed by (H. L. F. Huybrighs et al., 2020; Hans L. F. Huybrighs et al., 2017; Hans Leo Frans Huybrighs, 2018). The expected flux of the energetic ions is simulated under different scenarios, for three Galileo flybys of Io (I24, I27, and I31), including with and without an atmosphere and inhomogeneous magnetic and electric fields. By comparing the simulated distribution to the EPD data, the cause of the depletion features can be investigated.

The following causes of energetic proton depletion near Io are identified:

- Some depletions are consistent with atmospheric charge exchange for flybys I24, I27, and I31.
- Some of depletions coincide with the inhomogeneous fields produced in the MHD model by (Dols et al., 2012) for flybys I24, I27, and I31.
- For I24 the depletions are consistent with a two component atmosphere: a dense low scale height atmosphere and an extended corona described by a low surface density but a large scale height as presented by (Blöcker et al., 2018).

Furthermore, latitudinal and longitudinal dependencies in the atmospheric models for Io are investigated for all three aforementioned flybys.

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