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The Ganymede oxygen aurora: predictions for the JUICE mission

J.-C. Gérard (1), V. Shematovich (2), D. Bisikalo (2), D. Grodent (1)

(1) Laboratoire de Physique Atmosphérique et Planétaire, Université de Liège, Liège, Belgium, (2) Institute of Astronomy, Russian Academy of Sciences, Moscow, Russia (jc.gerard@ulg.ac.be Tel: +32-43669775)

Abstract

The set of instruments to be carried by the JUICE mission spacecraft will include the MAJIS infrared multispectral imager covering the spectral range extending from 1 to 5 μm and the UVS Ultraviolet imaging spectrometer. Molecular oxygen is believed to be one of the dominant atmospheric constituents of Ganymede.

We have investigated the vertical distribution and intensity of the Atmospheric Infrared O_2 bands in the Ganymede aurora. We assume the $O_2(a^1\Delta_g)$ molecules are excited by collisions of energetic electrons with the ground-state O_2 ($X\ ^3\Sigma$) state. This metastable state radiatively relaxes by emitting photons in the (0-0) and (0-1) bands at 1.27 and 1.48 μm respectively. Similarly, the OI triplet at 130.4 nm and the doublet at 135.5 nm are believed to be produced by electron impact on the O_2 ground state. Unlike the $O_2(a^1\Delta_g)$ emission, the FUV OI emission have been previously observed with the Hubble Space Telescope. The HST images show bright spots near 45° latitude, dropping toward the poles.

A Monte Carlo model simulation is used to calculate the degradation of the electron flux and calculate the local emission rate of the 1.27 μm band and the OI 130.4 nm and 135.6 nm multiplets. The O_2 column number density is varied within a factor of ten from the standard value. We assume that the lower energy population of the magnetospheric electrons is characterized by an energy ranging from 10 to 200 eV. The cross sections are taken from a recent review of the O_2 electron impact processes. As a consequence of the low atmospheric column density, we predict that all three emissions are concentrated near the satellite's surface. The nadir and limb intensities are calculated and their observability from Ganymede orbit are examined. We discuss the relative intensities of the three emission features and how their brightness and their ratio may be used as a diagnostic of the electron energy and the atmospheric density.

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