

Evidence of Europa neutral gas torii from Galileo EPD energetic sulfur ion measurements

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Abstract

The icy moon Europa is the source of an extended neutral cloud (also named torus) that populates most of the inner magnetosphere of Jupiter. The existence of this neutral structure has been previously inferred from observation of its effect on energetic protons. Indeed, charge exchange reaction with neutrals convert the energetic protons to energetic neutral atoms (ENA). The neutral torus therefore simultaneously creates ENAs, detected by Cassini during its Jupiter fly-by, and removes protons, an effect observed in-situ by the Energetic Particle Detector (EPD) onboard Galileo.

The Europa neutral torus should also act as a loss mechanism for energetic sulfur ions. Initial studies performed in 2003 did not find signatures of this process, maybe because the ions are multiply charged.

In this presentation, we revisit Galileo EPD measurements by focusing on instances when Galileo crossed the magnetic equator so that the full Pitch Angle Distribution (PAD) of ions can be observed. We will show never-reported signatures of the neutral torus in sulfur ions PAD, that independently confirm its existence. In addition, we find that energetic protons mainly charge exchange with a vertically thin oxygen torus (with a width H lower than 2 Jovian radii), while sulfur ions are mainly lost by interaction with a thick hydrogen torus (H higher than 3 Jovian radii). Energetic charged particles therefore reveal the existence of two Europa neutral torii. This finding is of prime importance for the future ESA JUICE mission that will observe ENAs.