The Io Plasma Torus State during the Juno Mission: Constrains from the Radio Occultations and the Io Auroral Footprint

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Jupiter has the strongest planetary magnetic field in the Solar System, and it is surrounded by a huge magnetosphere that extends for 50-100 Jovian radii (1 RJ = 71492 km). Io, the innermost Galilean satellite, orbits well within the magnetosphere of Jupiter, and hosts the most intense volcanic activity in the Solar System. The main volcanic material is SO_2, which supplies Io's atmosphere and the cloud of neutral particles around the satellite. The SO_2 is dissociated and ionized by collisions with the magnetospheric particles, therefore Jupiter is surrounded by a torus-shaped plasma cloud centred at Io's orbit called the Io Plasma Torus (IPT). The IPT is the main source of material for the whole Jovian magnetosphere. The presence of Iogenic plasma crucially determines the details of the ionosphere-magnetosphere coupling, and the magnetosphere size and compressibility, which in turn affects the magnetospheric response to the solar wind conditions at Jupiter. It is imperative to monitor the state of the IPT to determine its evolution and variabilities, as well as its effect on the whole magnetosphere.
Since 2016, the Juno spacecraft has been orbiting Jupiter with a highly eccentric, polar orbit: this geometry has been allowing us 1) to perform radio occultations of the IPT when Juno is near the closest approach to Jupiter and 2) to observe the auroral emission (called *footprint*) associated with Io's orbital motion. These two observables contain information about the distribution of plasma around Io's orbit: the radio occultations are determined by the total electron content between Juno and the Earth – including the IPT – while the footprint position by the Io-ionosphere currents, whose path is affected by the plasma density along the magnetic field lines through Io. Our analysis aims at determining the state and variability of the IPT using Juno data gathered since the orbit insertion in 2016. We use the occultations derived from the dual frequency radio tracking by the Gravity Science Experiment and the observations of the Io auroral footprint by the Jovian InfraRed Auroral Mapper (JIRAM) and the UltraViolet Spectrograph (UVS). These observations are compared with a theoretical model based on recent re-analyses of Voyager 1 data, which highlight secular variations and/or specific, time-limited conditions of the IPT.