GALILEO RADIO AND PLASMA WAVE OBSERVATIONS AT JUPITER: AN INVITED OVERVIEW

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On 7 December 1995 the Galileo spacecraft made a close (900 km) flyby of Io as it was inserted into Jovian orbit. This provided an opportunity to compare the Io torus with that observed by Voyager 1 in 1979 and to make the first ever observations of the immediate vicinity of Io. The Galileo plasma wave investigation found that the torus was a factor of two more dense than in 1979 [Gurnett et al., 1996a]. Near closest approach to Io, the wave instrument measured plasma densities as high as $4 \cdot 10^4$ cm^{-3} in the stagnant flow immediately downstream of the moon and several different types of wave phenomena.

During its orbital insertion, Galileo recorded an approximately 3-hour interval on its inbound trajectory through the torus and a 2-hour interval on the outbound leg. The inbound leg provided plasma wave spectra of the torus from about 7.6 R_J to about 5.4 R_J [Gurnett et al., 1996a]. The predominant wave mode in this region, outside of the Io closest approach was whistler mode hiss, characterized by abrupt intensifications from time to time. Throughout, the upper hybrid resonance band was visible, allowing for an accurate measure of the electron density along the trajectory. The density ranged from about 600 cm^{-3} to 4000 cm^{-3} through the torus into Io's vicinity. At the closest approach to Io, which happened to be in the corotational wake, the density peaked at $4 \cdot 10^4$ cm^{-3}, presumably reflecting the strong source of plasma associated with the volcanic activity on this moon. A brief, intense burst of broadband electromagnetic noise was found in this region, as well. Just outside of the wake, narrowband electromagnetic bands at harmonics of the proton cyclotron frequency were observed, suggesting an anisotropic distribution of protons, possibly due to pickup in the vicinity of Io.

The Galileo spacecraft made a close flyby of Jupiter's moon, Ganymede, on 27 June 1996. The plasma wave instrument onboard observed a wide array of plasma and radio wave phenomena that led Gurnett et al. [1996b] to conclude that Ganymede was surrounded by its own magnetosphere. At the same time, measurements of the magnetic field by the Galileo magnetometer led to the determination that Ganymede had an intrinsic magnetic field with an equatorial surface field strength of $\sim$ 750 nT [Kivelson et al., 1996].

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Figure 5 of the paper by Kurth et al. [this volume] provides an overview of the Ganymede wave observations from 300 Hz to the 5.62 MHz upper limit of the Galileo receiver. Ganymede's magnetosphere is sharply defined by magnetopause crossings near 0619 spacecraft event time (SCET) and 0700 as indicated by broadband bursts of electrostatic noise. These bursts correspond to abrupt rotations in the magnetic field that Kivelson et al. [1996] identify as magnetopause crossing. The closest approach to Ganymede occurs at about 0629 SCET, which can be seen as the time when the upper hybrid resonance band peaks in frequency at about 60 kHz. This band of emission is seen to rise smoothly to its peak and then drop off as the spacecraft recedes. Since the upper hybrid frequency is a function of the electron plasma density and magnetic field strength, Gurnett et al. [1996b] used it to determine the density of plasma in the vicinity of the moon with a peak of about 45 cm^{-3}. Briefly, just inside the inbound magnetopause crossing and then again for a more extended period of time prior to the outbound magnetopause crossing, a series of intense, narrowband emissions is seen that Gurnett et al. identified as electron cyclotron harmonic emissions, sometimes referred to as $(n + 1/2)f_{ce}$ bands. These are electrostatic emissions that lie between harmonics of the electron cyclotron frequency f_{ce}. At lower frequencies and peaking in frequency near closest approach is a broad band emission identified as whistler mode emission, probably including hiss at the lower frequencies and chorus at the upper frequency extent of the spectrum. This identification was made using magnetic field spectra (not shown in Figure 5 of Kurth et al. [this volume]). The maximum frequency of these emissions is typically at about one half of the electron cyclotron frequency in a planetary magnetosphere where the plasma frequency exceeds the electron cyclotron frequency as is the case at Ganymede. Based on this maximum frequency, Gurnett et al. [1996b] deduced that the maximum field intensity along the trajectory of Galileo was about 400 nT, very close to the observed value. Finally, weak narrowband emissions found in the frequency range of about 15 to 50 kHz outside of the magnetosphere are electromagnetic radio emissions generated by the conversion of electrostatic upper hybrid emissions into radio waves by a mode conversion process [Gurnett et al., 1996b; Kurth et al., 1997b]. The total power generated is about 1.6 kW, which is a factor of 10^6 weaker than the Jovian radio spectrum, but significant as the first planetary satellite acting as a unique radio source.

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