

Electron and Proton Whistlers Detected at Jupiter by the Juno Spacecraft

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During the first orbit of the Juno spacecraft, which was placed in orbit around Jupiter on July 5, 2016, the radio and plasma wave instrument detected numerous whistlers and associated proton whistlers. From early terrestrial observation in the 1950s, it is known that whistlers are produced by lightning and that they propagate in a right-hand polarized electromagnetic plasma wave mode known as the whistler-mode. This mode mainly involves interactions with electrons and for an impulsive source such as lightning has a dispersion at low frequencies that leads to characteristic decreasing frequency with increasing time, hence the term “whistler,” or sometimes “electron whistler.” Electron whistlers were first observed at Jupiter by the Voyager 1 spacecraft and provided the first evidence of lightning at Jupiter. Early terrestrial spacecraft measurements in the 1960s also showed that left-hand polarized electromagnetic waves were also excited by lightning, and that these waves interacted strongly with positively charged ions in the plasma. These waves propagate in a mode of propagations known as the electromagnetic ion cyclotron mode. For an impulsive source such as lightning, the dispersion of the ion cyclotron mode produces a series of tones that increase in frequency with increasing time, each of which asymptotically approaching an cyclotron frequency in the plasma. These left-hand polarized waves are now known as “ion cyclotron whistlers.” The Juno detection of proton whistlers is the first time that an ion cyclotron whistler has been discovered at a planet other than Earth. Measurements of the dispersion of both electron whistlers and proton whistlers provide useful constraints on the plasma density integrated along the path from the lightning source to the spacecraft. In this paper these path integrated measurements will be compared to models and previous radio occultation measurements of the electron densities in the ionosphere and magnetosphere of Jupiter.