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Juno Waves observations at Jupiter

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Abstract

The Juno spacecraft successfully entered Jupiter orbit on 5 July 2016. One of Juno's primary objectives is to explore Jupiter's polar magnetosphere. An obvious major aspect of this exploration includes remote and in situ observations of Jupiter's auroras and the processes responsible for them. To this end, Juno carries a suite of particle, field, and remote sensing instruments. One of these instruments is a radio and plasma wave instrument called Waves, designed to detect one electric field component of waves in the frequency range of 50 Hz to 41 MHz and one magnetic field component of waves in the range of 50 Hz to 20 kHz. Juno has now made scientific observations on several perijove passes beginning with Perijove 1 on 27 August 2016. This paper presents some of the early observations of the Juno Waves instrument.

Among radio emissions, kilometric, hectometric, and decametric emissions have been observed. From a vantage point at high latitudes, many of Jupiter's auroral radio emissions appear as V-shaped emissions in frequency-time space with vertices near the electron cyclotron frequency where the emissions intensify. We present observations suggesting Juno has flown through or close to several sources of these auroral radio emissions [1]. While the sources are typically found on field lines threading the main auroral oval, during Perijove 5 the geometry is consistent with a source near the Io flux tube, or the Io flux tube wake. Measurements by the Jovian Auroral Distributions Experiment (JADE) provide evidence of loss-cone electron distributions at some sources that are sufficient to drive the cyclotron maser instability [2]. Remote observations provide source locations for broadband kilometric radiation that are consistent with auroral field lines [3].

Waves observes whistler-mode hiss on auroral field lines and over the polar cap [4]. The hiss sometimes exhibits quasi-periodic intensity fluctuations in the range of a few to a few tens of minutes, similar to that of quasi-periodic (QP) radio bursts and temporal variations in some UV auroral emissions and X-ray hot spots poleward of the main oval. The hiss intensity exhibits a good correlation with upgoing energetic electrons observed by the Jupiter Energetic particle Detector (JEDI) [5]. It is enticing to consider the possibility that the hiss and energetic electrons are associated with the quasi-periodic emissions.

Juno's perijove passes carry it over high mid-latitudes where lightning is known to exist and, subsequently, lightning whistlers have been observed. Because of the strong magnetic field and the short propagation path through relatively low density plasma, the whistler dispersion is small; typical durations of the whistlers are of order 10 ms. Proton whistlers have also been observed on a few occasions, a first for this phenomenon in a non-terrestrial locale.

We also discuss observations of dust encountered in and near the equator. Collisions with dust grains with a spacecraft speed near 60 km/s results in the vaporization of the grain and even a small part of the target material creating a hot, instantly ionized gas. The result is an impulse easily detected by the Waves instrument. It is thought that these are micron-sized and are the result of material moving inward from Jupiter's ring.

Finally, we note more distant observations of the Jovian magnetosphere and its interaction with the solar wind as revealed by upstream plasma waves, encounters with the bow shock, and many magnetopause crossings highlighted by the appearance or disappearance of continuum radiation trapped in the low-density cavity in Jupiter's distant magnetosphere [6].

References

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