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Juno JADE observations at Jupiter

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Abstract

Since the crossing of the Jovian bow shock on 24 June 2016 the Juno mission has performed measurements of the plasma environment across the Jovian magnetosphere. In situ measurements of the plasma environment are performed by the Jovian Auroral Distributions Experiment (JADE) [4]. JADE measures the plasma using two nearly identical electron sensors and an ion sensor. The electron sensors (JADE-E) measure the electron distribution in the range of 100 eV to 100 keV. The un-deflected Field-of-View (FOV) of JADE-E is the spin plane of the spacecraft; approximately the plane which includes the spacecraft velocity direction and the local magnetic field. Around closest approach the JADE-E sensors use electrostatic deflection to track the local magnetic field direction in order to measure the pitch angle distribution with nearly 1 second time resolution. The JADE ion sensor (JADE-I) measures the energy per charge and time of flight (TOF) of incident ions to observe the composition-separated ion distributions. The JADE-I sensor measures the energy per charge in the range of 10 eV / q to 50 keV / q for ions with masses < 64 amu / q. Using the spacecraft spin to sweep its FOV, JADE-I measures a full 4Pi ion distribution function every 30 seconds.

The large orbit – apojove ~ 110 Rj with a 53.4 day period – allows the Juno spacecraft to periodically cross through the magnetopause into the magnetosheath. This is observed in JADE as the plasma changes from a shocked solar wind in the sheath with anti-sunward flows to co-rotating magnetospheric plasma with sunward flow (at the dawn flank) [2, 5]. We present observations of crossings of the magnetopause, observed with both the JADE-E and JADE-I sensors.

As the spacecraft travels inward toward the planet, JADE samples the plasma of the outer, middle, and inner magnetosphere. The polar orbit of Juno permits the direct sampling of both the lobes in addition to a large number of plasma sheet crossings each orbit. The JADE observations of the larger magnetospheric structure are presented here.

During times when Juno crosses the auroral regions, JADE-E found that the core of the energy distribution is generally within this energy range, going from about 100 eV, when Juno is on field lines that are connected to the inner plasmasheet, to several keVs, when Juno is connected to the outer plasmasheet, and to tens of keVs, when Juno is over the polar regions. JADE has observed upward electron beams and upward loss cones, both in the north and south auroral regions, and downward electron beams in the south. Some of the beams are of short duration (< 1 s) implying that the magnetosphere has a very fine spatial and/or temporal structure near the auroral regions [1]. Joint observations with the WAVES instrument have demonstrated that the observed loss cone distributions provide sufficient growth rates to drive the cyclotron maser instability [3].

The high velocity of the Juno spacecraft near perijove (~50 km/s) allows observations of very low energy ions in the spacecraft ram direction, down to below 1 eV/q. During the perijove passes when the

spacecraft is at sub-auroral latitudes the ion observations show two populations. The first appears to be of Iogenic origin based on its composition and velocity distribution [6]. The second population appears to come directly from Jupiter itself. This population consists of low energy, light ions, largely consisting of protons. The ions have energies below 100 eV in the spacecraft frame, and extend down to the bottom of the JADE measurement range. In this paper we will present observations of the ions in the sub-auroral regions and below an altitude of 1 Rj.

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