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Velocity moments in the outer nightside magnetodisk of Saturn

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Abstract

Saturn has a huge rotating magnetosphere, fields and particles exhibit rotational periodicities in all plasma parameters, the periods depend on epoch, elevation, etc. The rotating plasma forms a magnetodisk in the vicinity of the equatorial plane.

Studies by Andrews et al. [2012] and Provan et al. [2012] have shown that magnetic field modulation in the northern and southern lobe have distinct and different periods (the well known northern and southern periods), whereas in the magnetodisk both periods are present and changing smoothly with the distance from the equatorial plane; near the current sheet the magnetic field exhibits dual periodicities, roughly of equal amplitudes.

The disk has a complex shape depending on local time, seasons of Saturn, and external forces (SW), and it is tilted, possibly due to currents. The non-rigid rotation of the tilted disk imitates flapping, that is a periodic vertical motion in the outer magnetosphere for an observer such as Cassini. Wherever the central line intersects the radial component of the magnetic field, the radial component is about zero, and the ion densities reach their peak values [Szego et al., 2011].

The results of recent numerical simulations [Jia and Kivelson, 2012] show that in the magnetodisk of Saturn fluctuating magnetic field perturbations are accompanied by other oscillatory phenomena. They investigated the magnetotail response for a dual periodicity driver in the case when the solar wind flow was perpendicular to the rotation axis. It was demonstrated that the components of the flow velocity extracted at different radial distances plotted versus time exhibit periodic modulation.

We have investigated periodicities in the azimuthal and latitudinal component of the flow velocities using the numerical ion moments derived from the measurements of Cassini Plasma Spectrometer [Thomsen et al, 2010]. Ramer et al. [2012] investigated these periodicities in the inner magnetosphere near the equatorial plane. We have found that the azimuthal velocities show oscillatory behavior in the outer magnetosphere. It was found that the dense plasma near the magnetic equator rotates around the planet at high speed, while the dilute plasma of higher latitudes of the north and south hemispheres is rotating significantly slower.

This observed latitudinal gradient in the azimuthal speed as a function of the distance from the equatorial plane can be a direct consequence of the sub-corotation of the plasma in the outer magnetosphere; highest speeds occurring on field lines at lowest latitudes mapping the rapidly rotating inner regions of the plasmasheet, and the speed falling as one approaches the lobe, where the field lines are connected to far away strongly sub-corotating plasma. This suggests a picture of the magnetodisk, in which each L-shell rotates more or less rigidly, but the rotation speed is decreasing with L increasing.

The dayside magnetodisk structure differs in many respects from the properties observed nightside. We shall point out some of these differences.

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