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The Structure of Planetary Period Oscillations in Saturn's Equatorial Magnetosphere: Results from the Cassini Mission

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Abstract

Saturn's magnetospheric magnetic field, planetary radio emissions, plasma populations and magnetospheric structure are all known to be modulated at periods close to the assumed rotation period of the planetary interior. These oscillations are readily apparent despite the high degree of axi-symmetry in the internally produced magnetic field of the planet, and have different rotation periods in the northern and southern hemispheres. In this paper we study the spatial structure of (near-) planetary period magnetic field oscillations (PPO) in Saturn's equatorial magnetosphere. Extending previous analyses of these phenomena, we include all suitable data from the entire Cassini mission during its orbital tour of the planet, so as to be able to quantify both the amplitude and phase of these field oscillations throughout Saturn's equatorial plane, to distances of 30 planetary radii. We study the structure of these field oscillations in view of both independently rotating northern and southern systems, finding spatial variations in both magnetic fields and inferred currents flowing north-south that are common to both systems. *(As submitted to J. Geophys. Res., 2019).*

1. Introduction

In this paper we update the results initially presented by *Andrews et al.* [1] by firstly altering the analysis technique to account for the superposition of independently rotating northern- and southern-hemisphere systems of PPO fields and currents in the equatorial magnetosphere. Secondly, we greatly increase both the volume and spatial coverage of magnetic field data analysed, using additional data obtained by Cassini since the initial study was conducted. Time-varying rotation periods and amplitudes for the "core" region of Saturn's PPO magnetic field, determined in a series of related papers are used as a guide, against which local relative amplitudes and phases are determined in spatial bins on the equatorial plane.

2. Sample Results

Figure 1 shows sample results obtained in this analysis, in a format appropriate to the southern hemisphere PPO system. Colored arrows show magnetic field vectors, determined from sinusoidal fits of processed magnetometer data in spatial bins of 2 h width in local time and 3 planetary radii in radial distance. Individual vectors are displayed as computed at 0º of rotational phase. The north-south component of the current density is computed from these field vectors using a centered difference scheme, and is shown by the underplotted colored areas.

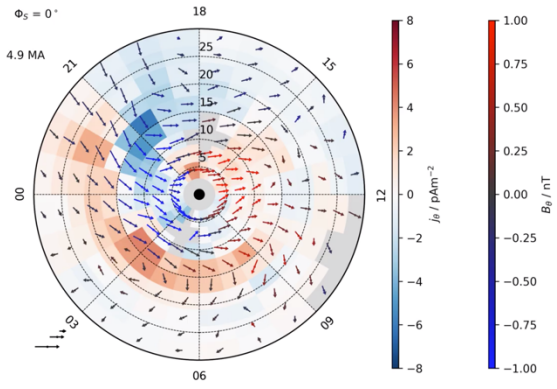

Figure 1: Sample results showing PPO fields and computed north-south currents.

3. Summary and Conclusions

In a significant update to the results obtained by Andrews et al., [1] we find

- no evidence for systematically different amplitude or phase structures associated with the northern and southern hemisphere PPO systems.
- significant dawn-dusk asymmetries in both the amplitude and the phase of the PPO fields.
- modulation of the north-south currents in the nightside magnetosphere associated with the periodic displacement of the plasma sheet current. Accounting for this effect yields comparable estimates for the total current carried in the system to those obtained from analyses of high-latitude magnetic field data from Cassini.
- a simpler and more coherent structure to the north-south currents than previously described, comprising of two rotating interlinked spirals of currents.

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References

[1] Andrews, D. J., S. W. H. Cowley, M. K. Dougherty, and G. Provan (2010), Magnetic field oscillations near the planetary period in Saturn's equatorial magnetosphere: Variation of amplitude and phase with radial distance and local time, *Journal of Geophysical Research (Space Physics),* 115, A04212, doi:10.1029/2009JA014729.