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Magnetohydrodynamics of the 10.7 hr Magnetic Periodicities in Saturn's Magnetosphere

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Abstract

The observed features of the global 10.7 hour period magnetic signals of the Saturn system are analysed using the reasonable guiding hypothesis that the phenomena are magnetohydrodynamic in origin. In uniform plasma shear and compressional waves are separated. Inhomogeneity causes the coupling of the shear and compressional plasma motion but because of the anisotropy of the magnetic stress, it is still important to analyse compressional and shear effects independently and then allow for coupling. Three regimes can be defined where behavior of fields is very different. These are the flux tubes that are permanently closed and those that are permanently open (polar cap) and the open-closed boundary regime between these regions, where field lines open and sporadically (and periodically) release trapped material into interplanetary space. A central question to deriving a global picture is the manner in which the 10.7 hour signals connect across the interfaces between regimes. Globally the model we deduce predicts fields and plasma behavior largely indistinguishable from the recent global computations of Jia et al.[1] However there are limitations to the detail that any computation can reproduce. Moreover, we show that the source vortices introduced in the computations arise as a natural feature of the Saturn plasma environment.

References

[1] Jia, X., M. G. Kivelson, and T. I. Gombosi (2012a), Driving Saturn's magnetospheric periodicities from the upper atmosphere/ionosphere, J. Geophys. Res., 117, A04215, doi:10.1029/2011JA017367.