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Radial and Local Time Variations in the Thickness of Jovian Current Sheet

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The Jovian current sheet located close to the equatorial plane of Jupiter is the main repository of its magnetospheric plasma. The shape of the Jovian current sheet and the forces working to deform it are now reasonably well understood thanks to many earlier works, the ideas from which were quantified in much detail by Khurana and Schwarzl (2005). On the other hand, variations in the thickness and therefore the plasma content of the current sheet with radial distance and local time are poorly understood because thickness determination requires a knowledge of the motion of the current sheet relative to the observing spacecraft which is hard to get. Consequently, no systematic studies have been performed so far that characterize the behavior of Jupiter's current sheet thickness in space and time.

We have now developed a new technique to determine the instantaneous motion of Jupiter's current sheet relative to a stationary observer. The new technique allows us to quantitatively model the magnetic field (and a limited electron density dataset) as Harris-type current sheets, resulting in new estimates of thickness and plasma content of Jovian current sheet in all local times and radial distances. Our work shows that the Jovian current sheet is at its thinnest in the dawn sector and is the thickest in the dusk sector. The current sheet thickness on the dayside are comparable to those in the dusk sector where as the nightside current sheet thicknesses are intermediate to the dawn and dusk sector values. A comparison of the particle density and magnetic field profiles through the current sheet reveals that the plasma sheet (as defined by the electron density data) and the current sheet have very similar extents.

Our analysis provides valuable insights into how local time asymmetries are generated and maintained in Jupiter's magnetosphere. Further analysis of this data set would help us infer how external and internal agencies influence the transport and redistribution of plasma in Jupiter's magnetosphere.

References:
Khurana, K.K., and Schwarzl, H. K., The global structure of Jupiter's magnetospheric current sheet, J. Geophys. Res., 110, A07227, 2005.