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Factors Controlling the Thickness of the Jovian Current Sheet

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The Jovian current sheet is the main repository of Jupiter's magnetospheric plasma. Spatial variations in its thickness and therefore its plasma content 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. Recently, we have developed a new technique that uses the timings of any three consecutive current sheet crossings to determine the instantaneous motion of Jupiter's current sheet relative to the spacecraft. Next by using this technique and modeling the magnetic field and electron density dataset in terms of Harris current sheet type equilibria we can estimate the thickness and plasma content of the Jovian current sheet over all local times and radial distances. Our modeling of Juno and Galileo magnetic field data shows that in all local times the current sheet thickness increases with radial distance. We also find that the Jovian current sheet is highly asymmetric in local time, being at its thinnest in the dawn sector and the thickest in the dusk sector. The current sheet thickness on the dayside is comparable to that in the dusk sector. The nightside current sheet is intermediate in its thickness to the dawn and the dusk sectors.

We show that the increase in the thickness of the current sheet with radial distance can be explained in terms of the increasing temperature and therefore the plasma beta of the current sheet with radial distance. However what causes the sharp local time variations of the current sheet is not yet fully understood. We will discuss several models of plasma transport and redistribution in Jupiter's magnetosphere that can create local time differences in the plasma content and therefore the current sheet thickness. These models have testable implications for the structure of the magnetosphere (open versus closed, convective versus diffusive transport of plasma etc.).