Characteristics of the Dawn side Magnetopause

The Cluster mission is providing the first ever four-spacecraft measurements of the Earth's plasma environment. Here we utilize Cluster's multispacecraft capabilities to study the thickness, speed and current densities of Earth's magnetopause. We find a large range of thicknesses, from less than 200 km to thousands of km, uncorrelated with any properties of the solar wind or the interplanetary magnetic field.

The magnetopause is a thin sheet of electric current that separates the solar wind from the Earth's magnetic field. When this boundary moves over a spacecraft, its instruments will record abrupt changes in magnetic field and plasma properties, but as the speed of the boundary motion is unknown a-priori, one cannot determine its thickness.

With Cluster, one can use the timing of the crossings recorded by the four spacecraft to directly determine the orientation and velocity of the magnetopause, and from this calculate its thickness. Together with the known changes in the magnetic field across the current layer one can also compute the net electric current flowing within the magnetopause. Figure 1 shows the results for 96 crossings of the dawnside magnetopause. in terms of the number of cases that fell within specified ranges of thickness, speed, and current.

Particularly striking is the large range of thicknesses, from less than 200 km to thousands of km. In simple models the magnetopause thickness should scale as the ion gyro-radius, because the gyro radius determines how deep the incident solar wind ions should penetrate the Earth's magnetic field. But the gyro radius was measured to be only about 50 km for the cases studied. Thus the magnetopause is usually much thicker than simple theory prediicts. Curiously, we find the variations in thickness uncorrelated with any properties of the solar wind or the interplanetary magnetic field.

The middle panel demonstrates the large range in magnetopause speeds, from less than 10 to several hundred km/s. This illustrates that one cannot infer the magnetopause thickness simply from the duration of the crossings. The bottom panel, finally, indicates that the current denities are typically 0.1 $\mu A\,m^{-2}$.

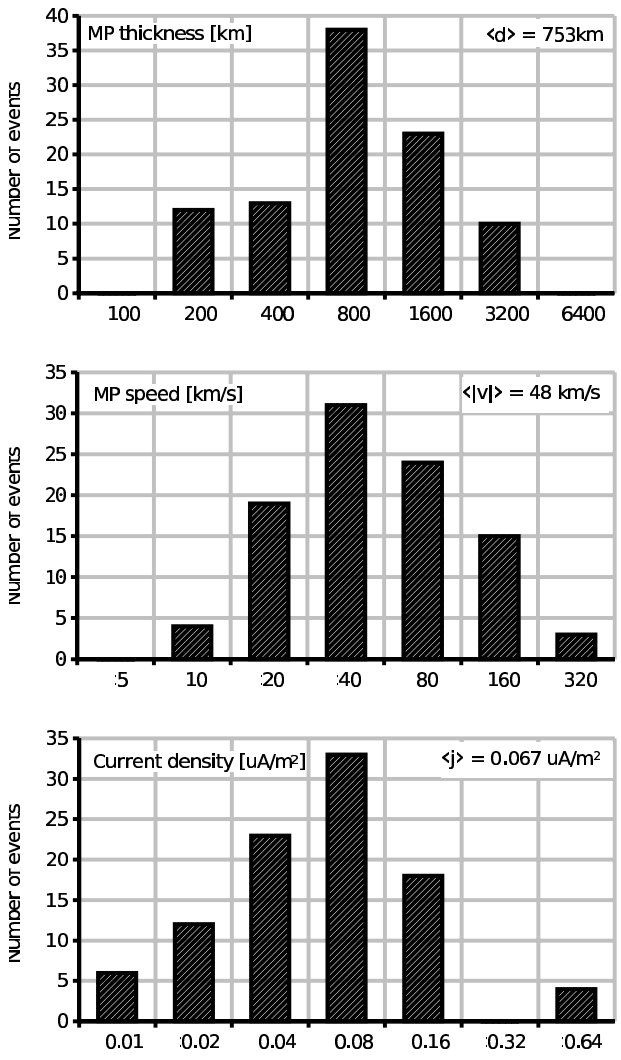

Fig 1. Histograms of magnetopause speed, thickness and current density for 24 dawn flank magnetopause crossings by all four Cluster spacecraft on 5 July, 2001, resulting in a total of 96 individual crossings. Note that the bins are logarithmically spaced.

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