

Reconstruction of two-dimensional magnetopause structures based on Cluster multi-spacecraft measurements

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A data analysis technique developed recently for reconstructing approximately two-dimensional, time-stationary magnetic field structures in space is applied to a few magnetopause traversals on the dawn flank by the four Cluster spacecraft, when the spacecraft separation was about 2000 km. The method consists of solving the Grad-Shafranov equation for magnetohydrostatic structures, utilizing plasma and magnetic field data measured along a single spacecraft trajectory as spatial initial values. In the first part of the study, this single-spacecraft based technique is tested, by comparing the magnetic field map recovered from one spacecraft with the field values the other spacecraft actually observed, and by examining consistency of the field maps produced individually for two of the spacecraft (C1 and C3), both of which provide complete plasma information. In the second part, the technique is extended such that a single field map, which is optimal under the assumption that the structures are two-dimensional and time-independent, can be generated using data from all four spacecraft as input. We show, based on the reconstruction results, that the magnetopause surface is not planar, but has a significant curvature, even on a scale of a few thousand km, and that the thickness of both the current sheet and the boundary layer attached inside can occasionally be larger than 3000 km.