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Structure and motion of the magnetotail current sheet during flapping

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Using magnetic field, plasma, and electric current characteristics during 78 rapid crossings of the magnetotail current sheet by Cluster during July - October 2001, we found that most of rapid crossings are due to kink-like transients passing over the spacecraft. The normals to the kink fronts are tilted in the $Y - Z$ plane, in 54 % of the studied cases the tilt angle exceeds 45°. The electric currents exhibit a corresponding behavior. The kinks fronts are often close to vertical with $|j_z| > j_y$, and sometimes over-steepened (j_y <0). In 8% of the cases, the Y-component of the kink front velocities were negative in the postmidnight sector and positive in the premidnight sector, showing that the kink waves propagate from the near-midnight sector toward the flanks. The remaining 11% of the cases were mainly situated between 0< Y <8 R_E. The half-thickness of the current sheet during the flapping varies from 1 to 20 ion thermal gyroradii (calculated using the lobe magnetic field). No relationship between half-thickness and tilt of the normal was found. In 68 of 78 cases, the magnetic field curvature vector was directed Earthward (positive curvature). The 10 cases with a negative curvature, as well as high speed flow events, were found at 0≤ Y ≤8 R_E. The minimum curvature radius varies between 500 and 10000 km, showing no close relationship with the sheet half-thickness estimate. In 73% of the crossings the adiabaticity parameter κ, ruling ion motion in the current sheet, is less than unity. In 55% of studied cases the flapping current sheets have a center peak distribution, with the current density maximum at B_x ∼0, and in 45% the current density distributions were off-center, with the main current shifted from the neutral sheet.