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Dynamic structure of the magnetotail current sheet observed by Cluster

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Studies of the magnetotail current sheet using four-point Cluster measurements during flapping intervals show the existence of three types of structures: I) Symmetric single-peaked sheets with the current density maximum in the equatorial plane (B_x=0); II) bifurcated sheets with two quasi-symmetric current density maxima separated by a minimum in the equatorial plane; and III) asymmetric sheets with an off-equatorial current density maximum. All three types the current sheet are embedded into a thicker plasma sheet. Thus, flapping is due to kinking of the relatively thin current sheet inside an ambient plasma sheet. Observations of asymmetric off-center structures indicate that the kink-like structures coexist with transient smaller amplitude sausage-like variations. It was found that temporal expansion and thinning of the current sheet has a time period about half of the kink-type oscillations time period. Similar results were found in the particle-in-cell simulations of the non-Harris current sheet dynamics. A simultaneous observations by Cluster and Double-Star TC-1 show that the kink-like structures can be radially elongated up to 5 R_E or more. The X-elongated corrugation of the current sheet surface was also observed in global MHD simulation of the flapping event. The global simulations also show rapid changes of the current sheet structure associated with the plasma flow intensification.