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Influence of nonlinear dynamics of charged particles on fine structure and dynamics of thin current sheets in the Earth's magnetotail

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Thin current sheets (TCS) in the Earth's magnetotail are often found to have very complicated spatial structure with proper internal scales and the active nonlinear motion of their spatial configuration as whole. The newest CLUSTER observations revealed many TCSs properties which can not be explained in frames of existing models. For example, the double-humped structure of TCS in the near-Earth edge of current sheet is found during some substorms. Contrary to usual MHD approach for the description of the magnetotail configuration, these peculiarities of TCS and corresponding multilayer structure of cross tail current should be described using kinetic approach only. The 1D kinetic self-consistent model is proposed to describe the essential properties of thin current sheet. Both trapped and transient nonadiabatic ion orbits are taken into account. It is shown that the splitting of CS profile near the tail midplane, i.e. the appearance of two layers of ion currents, is due to the local currents of quasi-trapped ion population. Two layers of negative diamagnetic ion currents appear at the edges of CS, producing overshoots of magnetic field at the interface with magnetotail lobes. The electron component which also contributes to the fine structure of CS, is taken into account. It is shown that in the case of isotropic electron pressure the corresponding ExB electron drifts result in additional splitting of cross-tail current. Contrary to this case the population anisotropic electrons might carry a single narrow peak of electron

current associated with a curvature drift. This mechanism leads significant steepening of magnetic field profile at the center of CS. It is shown that the asymmetry of TCS might be very important factor in the formation of TCS fine structure and might influence its large-scale properties. All these features reflect the proper features of CS equilibrium and might be used for its diagnostic in space.