Cross-Tail Instabilities in the Magnetotail Current Sheet I. Linear Analysis

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In the magnetotail the current sheet thins during the growth phase of a substorm. In such a thin current sheet current flow is possibly unstable to various instabilities To understand the nature of the cross field current instability we calculated the linear eigenvalue problem of the cross-field current instability for the 1D Harris-type current sheet using the two fluid model with the finite electron mass effect. As a result we find a new instability as well as the K-H instability. The growth time of this new instability is comparable to that of the K-H instability, and its wavelength can be scaled by the hybrid inertia length. In this paper we present general properties of the new instability and discuss what roles this instability plays in the magnetotail and the magnetopause.