Effects of the K-H instability on plasma mixing and transport in the geomagnetosphere: PSD observations and PIC simulation

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In the nightside region of near-Earth space, a large-scale region called the plasma sheet is formed through interaction between the intrinsic terrestrial magnetic field and the solar wind (a super sonic plasma flowing from the sun). The plasma sheet becomes much cooler and denser than usual under prolonged northward interplanetary magnetic field (IMF) conditions [1]. However, the mechanism responsible for the formation of CDPS is still far from understood. The Kelvin-Helmholtz (K-H) instability driven by the velocity shear at the magnetopause has been proposed as a possible mechanism of magnetosheath plasma entry through the LLBL (low latitude boundary layer) [2,3,4]. On one hand, ”Double lobe reconnection”, i.e., reconnection of a magnetosheath flux tube with lobe field at the high-latitude magnetopause in both hemispheres, thereby becoming closed, is also an important candidate process for the dense, thick LLBL formation during northward IMF periods [5].

In this study, observations of electron and ion phase space densities (PSDs) from the dayside to the nightside magnetosphere are compared with results from full-particle simulation of the K-H instability in the magnetized plasma with a density gradient [6] so as to examine roles of the K-H instability in effective plasma transport seen in the Earth’s magnetotail. The results indicate that the ”double lobe reconnection” is responsible for formation of the outermost part of LLBL in the dusk flank, but does not directly form the plasma mixing region consisting of the main part of LLBL at the tail flank. Comparison of LLBL and CDPS observations with the simulation result, on one hand, suggests that a wavy structure observed in the LLBL is consistent with the non-linear phase of the K-H instability and that the K-H instability plays an important role in the plasma mixing in the LLBL and in formation of the CDPS. It is also shown that these CDPS plasma can be transported into geosynchronous orbit after the southward turning of IMF.

References:
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