EXPERIMENTAL EVIDENCE FOR MULTIPLE RECONNECTION

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Ion and electron velocity distributions can be used as tracers of the magnetic field topology. The topology of magnetospheric boundary layers and associated problem of single point or multiple reconnection are not sufficiently understood. We use Interball/Tail measurements of ion and electron velocity distributions in an attempt to better understand LLBL magnetic topology.

Three typical types of ion velocity distributions are observed within highly-structured LLBL under southward and variable magnetosheath magnetic field: (a) D-shaped distributions, (b) ion velocity distributions consisting of two counter-streaming components of magnetosheath-type, and (c) distributions with three components one of which has nearly zero parallel velocity and two counter-streaming components. Only the (a) type fits to the single magnetic flux tube formed by reconnection between magnetospheric and magnetosheath magnetic fields. We argue that two counter-streaming magnetosheath-like ion components within LLBL cannot be explained by the reflection of the ions from the magnetic mirror deeper within magnetosphere. Types (b) and (c) ion velocity distributions would form within spiral magnetic flux tubes consisting of a mixture of alternating segments originating from the magnetosheath and from magnetospheric plasma. The shapes of ion velocity distributions and their evolution with decreasing number density in LLBL indicate that a significant part of LLBL is located on magnetic field lines of long spiral flux tube islands at the magnetopause, as has been proposed and found to occur in magnetopause reconnection simulations.

LLBL is characterized by enhanced electron parallel temperature, called bi-directional velocity distribution. It is also well known that electron temperature within the LLBL increases with decrease of LLBL number density. We found that parallel electron velocity distribution is changing self-consistently with varying number density in the LLBL. Namely, the shape of parallel velocity distribution does not change in log-log scale indicating that electron parallel velocities increase in the same proportions as the number density in the LLBL decreases. We consider these ion and electron observations as additional evidence for multiple reconnection X-lines between magnetosheath and magnetospheric flux tubes.