Cluster Observation of the Diffusion Region in the Center Plasma Sheet

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Abstract

On 15 September 2001 at 0500-0508 UT Cluster fortuitously encountered with the ion diffusion region in the center plasma sheet at the GSM coordinates (-18.7, 3.5, -2.9) R_E. For the first time more than one spacecraft simultaneously stayed near the X-line and traversed the separatrix several times. The constellation conducted a detailed multiple spacecraft measurements of magnetic reconnection in/near the diffusion region. A comprehensive study of micro-properties of reconnection is made in this paper. In addition to show the distinct quadrupolar out-of plane magnetic field component associated with the decouple of electrons from the ions in the ion inertial region, we report the following interesting findings.

(1) By doing the best current sheet fitting based on four spacecraft measurements, we obtain that during this reconnection event the current sheet thickness L_z ~ 556 km~ 1.34 d_i, where d_i~416 km stands for the ion inertial length.

(2) The separatrix angle can be estimated to be $15^0 \leq \theta \leq 20^0$, and hence the length of the diffusion reign L_x ~ (3.7-5.0) d_i (1539.2-2080.0) km.

(3) By directly estimating the inflow V_i or obtaining V_i through the conservation low, we find the reconnection rate for this event to be $R = V_i / V_A$ ~ (0.08-0.13), in agreement with simulation results of GEM challenge and other theoretical prediction..

(4) Relative low energy electrons (~1 keV) and higher energy electrons are flowing into and out of the diffusion region, respectively. The low hybrid type waves are seen in the edge of the ion inertial region B_y configuration, there is a narrow area close to the X-line in which an anti-quadrupolar B_y component can be identified.

(6) The X-point is found to be always in motion with the shift speed being a few tens to a few hundreds km/s.

Detailed studies of particle dynamics in the diffusion region are highly desired for a better understanding of aforementioned micro-properties of magnetic reconnection.

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