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Particle Dynamics at and near the Electron and Ion Diffusion Regions as a Function of Guide Field

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At the dayside magnetopause, magnetic reconnection often occurs in thin sheets of plasma carrying electrical currents and rotating magnetic fields. Charged particles interact strongly with the magnetic field and simultaneously their motions modify the fields. Researchers are able to simulate the macroscopic interactions between the two plasma domains on both sides of the magnetopause and, for precise results, include individual particle motions to better describe the microscopic scales. Here, observed ion and electron distributions are compared for asymmetric reconnection events with weak-, moderate-, and strong-guide fields. Several of the structures noted have been demonstrated in simulations and others have not been predicted or explained to date. We report on these observations and their persistence. In particular, we highlight counterstreaming low-energy ion distributions that are seen to persist regardless of increasing guide-field. Distributions of this type were first published by Burch and Phan [GRL, 2016] for an 8 Dec 2015 event and by Wang et al. [GRL, 2016] for a 16 Oct 2015 event. Wang et al. showed the distributions were produced by the reflection of magnetosheath ions by the normal electric field at the magnetopause. This report presents further results on the relationship between the counterstreaming ions with electron distributions, which show the ions traversing the magnetosheath, X-line, and in one case the electron stagnation point. We suggest the counterstreaming ions become the source of D-shaped distributions at points where the field line opening is indicated by the electron distributions. In addition, we suggest they become the source of ion crescent distributions that result from acceleration of ions by the reconnection electric field.

Burch, J. L., and T. D. Phan (2016), Magnetic reconnection at the dayside magnetopause: Advances with MMS, Geophys. Res. Lett., 43, 8327–8338, doi:10.1002/2016GL069787.

Wang, S., et al. (2016), Two-scale ion meandering caused by the polarization electric field during asymmetric reconnection, Geophys. Res. Lett., 43, 7831–7839, doi:10.1002/2016GL069842.