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Experimental Study of Non-MHD Effects During Fast Reconnection[1]

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Magnetic reconnection is the topological change of magnetic field lines during which magnetic energy is converted to plasma energy. One of the important goals in magnetic reconnection research is to explain the fast reconnection rate observed in laboratory, space and astrophysical plasmas. Recent breakthroughs show that non-MHD effects, including the Hall effect and electromagnetic fluctuations, can facilitate fast magnetic reconnection. The Hall effect has been found to drive fast magnetic reconnection in 2D numerical simulations [1]. A hallmark of the Hall effect is an out-of-plane quadrupole field in the reconnection region, which has been clearly observed in the Magnetic Reconnection Experiment (MRX) [2,3]. The spatial scale of the quadrupole field and the electron flow pattern agree well with numerical simulations. Measurements also show that the Hall effect is more significant in the collisionless regime than in the collisional regime, indicating that the Hall effect plays an important role in collisionless fast reconnection. Furthermore, Mach probe measurements demonstrate that the ion outflow is much slower than the electron outflow. Magnetic fluctuations in the lower-hybrid frequency range have been observed along with the quadrupole field; these fluctuations happen not only in the current sheet center region [4], but also in the outflow region. Comparisons with space observations will be discussed. In collaboration with M. Yamada, H. Ji, S. P. Gerhardt, A. Kuritsyn, R. Kulsrud and H. Torreblanca.

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