SH31A-1092 0830h POSTER

Hall Mediated Reconnection in Wide Current Sheets

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We examine the collisionless reconnection process in the double tearing mode system. Previous studies with very thin equilibrium current sheets found that the Hall term played a key role in allowing Alfvenic reconnection to occur, with the reconnection rate being insensitive to the system size length and the wavelength of the initial x-line perturbation. We generalize these results to systems with very wide equilibrium current sheets, examining both the scaling of the reconnection rate versus system size, and the criteria necessary to allow Hall physics to accelerate the reconnection rate. It is necessary to renormalize the reconnection rate to the magnetic field just upstream of the dissipation region in order to compare the relavent reconnection rates, and we have developed a numerical technique to do so. We find that the asymptotic reconnection rate is insensitive to both the system size and the wavelength of the initial x-line perturbation, as long as both of these values are sufficiently larger than c/ω_{pi}.

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Hall and Turbulence Effects on Magnetic Reconnection

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We reexamine the influence of the Hall effect and the level of background MHD scale turbulence upon the reconnection rate of a large scale periodic sheet pinch in 2.5 dimensional compressible Hall MHD. The simulations indicate that the large scale reconnection rate is enhanced by both increasing Hall parameter and by increasing turbulence level. The reconnection rate is found to scale linearly with turbulence amplitude and as the 3/2 power of the Hall parameter (correlation scale/ion inertial scale). The effect is quantified for a range of parameters, thus helping to clarify and extend the related GEM challenge simulation study of reconnection rates.

SH31A-1094 0830h POSTER

Laboratory Observation of Fast Collisionless Reconnection*

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Magnetic reconnection in the collisionless regime is studied on the Versatile Toroidal Facility (VTF). The detailed evolution of the profiles of plasma density, current density, and electrostatic potential at the onset of driven reconnection is reconstructed experimentally. Despite a constant, externally imposed reconnection drive, we show that the reconnection does not proceed in a steady-state manner. The formation and decay of the current is shown to be related to the evolution of the electrostatic potential and the associated ion polarization currents. The size of the diffusion region is inferred from the detailed knowledge of the electrostatic potential, and is shown to scale with the drift orbit width of the electrons insensitive to the ion mass and plasma density [1]. The accurate characterization of the steady state electric and magnetic field profiles provides an excellent basis for detailed kinetic simulations of the reconnection process. With the known electric and magnetic fields Liouville's equation is readily solved numerically providing the detailed phase space distribution function of the electrons. The current profiles, obtained from the first moment of the theoretical electron distribution function, are consistent with the measured current profile. Also consistent with VTF experiment results, the theoretical current densities are three orders of magnitude below the classical value, E/η_S. The phase space distributions of the electrons reveal non-Maxwellian features, which are fundamental in accounting for the momentum balance of the electrons in the vicinity of the X-line. The strong non-Maxwellian features also represent a source of free energy which can excite electromagnetic instabilities and fluctuations. [1] Egedal J, Fasoli A and Nazemi J, (2003) Phys. Rev. Lett. 90, 135003. * This work is supported by DOE and NSF

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Observation of the lower-hybrid drift instability in a laboratory current sheet

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The exact role of turbulence in collisionless magnetic reconnection has been a controversial theoretical topic, with some theories suggesting it is essential to provide anomalous resistivity, while others present a laminar fast reconnection mechanism based on the Hall term in the generalized Ohm's law. A thorough study of fluctuations in the current sheet of the Magnetic Reconnection Experiment (MRX) was performed in order to aid in resolving this controversy. Using amplified Langmuir and magnetic probes, we have measured broadband fluctuations in the lower hybrid frequency range ($f \sim 10-15$MHz) which arise with the formation of the current sheet in MRX. The frequency spectrum, spatial amplitude profile, and spatial correlations in the measured turbulence were examined carefully, finding consistency with theories of the lower-hybrid drift instability (LHDI). The observation of the LHDI in MRX has provided the first opportunity to experimentally study its role in the process of magnetic reconnection. It was found that: (1) the LHDI amplitude does not correlate well in time or space with the reconnection electric field (which is directly related to the rate of reconnection) and (2) the LHDI amplitude was found to be fairly insensitive to collisionality, unlike the measured resistivity anomaly. These two findings suggest that the LHDI does not play an essential role in determining the reconnection rate in MRX.

SH31A-1096 0830h POSTER

Laboratory Investigation of Boundary Layer Processes Due to Strong Spatial Inhomogeneity*

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Boundary layers are often found in laboratory plasmas, such as at the edges of laser-produced plasmas, and in natural settings, such as the magnetosphere. These are regions in which plasma characteristics undergo rapid transition and are usually the sites of wave activity. An investigation of boundary layer processes has been conducted in the NRL Space Physics Simulation Chamber (SPSC). A method has been developed to create a boundary layer with controllable density gradients and transverse electric fields with arbitrary amplitude and scale length as small as one-fourth of an ion gyroradius. This method involves interpenetrating plasmas with different diameters, whose plasma potentials can be controlled. Under these conditions, waves in the lower hybrid frequency range have been observed and their characteristics documented. Theoretical work indicates that the observed mode characteristics are similar to those expected for the Electron-Ion Hybrid Instability. As an illustration, we apply our results to space plasmas and the dynamics of the plasma sheet boundary layer (PSBL). The PSBL is key in the transfer of solar wind mass, energy, and momentum into the magnetosphere and ultimately into the auroral regions. During times of solar activity, the PSBL can become compressed to widths on the order of an ion gyroradius and can contain localized transverse electric fields similar to those generated in the SPSC experiments. At these times, thin layers of energetic electrons and broadband wave activity have been observed in the PSBL. The details of the response of a plasma to such conditions and the observable signatures are the focus of this study. *Work supported by ONR.

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Microphysics of Magnetic Reconnection: Experiments on RSX and Simulation

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Using a unique LANL laboratory facility, the Reconnection Scaling Experiment (RSX), and a state-of-the-art LANL numerical code, CELESTE3D, we are beginning an experimental and numerical study of the microphysics of 2D and 3D "fast magnetic reconnection". RSX at Los Alamos National Laboratory is already operational and producing research plasmas. In RSX, the radial boundaries and thus the reconnection geometry are not constrained to two dimensions. It is capable of investigating 3D magnetic reconnection occurring in a free-boundary 3D linear geometry during the coalescence of two parallel current plasma channels, which are produced by using plasma gun technology. RSX can also scale the guide field (ion gyroradius) independently of other reconnection parameters. Frontier reconnection research invokes (1) anomalous' microinstability-induced resistivity, which enhances dissipation rates inside the reconnection layer and (2) terms of the two-fluid generalized Ohm's law which introduce whistler and kinetic Alfvén wave dynamics. The two-fluid approach predicts (a) a two-spatial-scale spatial structure of the reconnection layer, with outer (inner) thickness equal to the ion (electron) skin depth and (b) Hall currents in the reconnection plane and out-of-plane magnetic field on the electron scale. We will show spatially resolved RSX experimental measurements of the dynamics of the reconnection layer, and take advantage of our scaling capabilities to address the applicability of the two-fluid approach.

URL: http://wsx.lanl.gov/

SH31B MCC: 2002-2004 Wednesday 0900h

Van Allen Lecture *(joint with SA, SM)*

Presiding: **D Baker,** Laboratory for Atmospheric and Space Physics, University of Colorado**; R Strangeway,** Institute of Geophysics and Planetary Physics, University of California, Los Angeles

SH31B-01 0910h INVITED

New Insights Into Magnetospheric Physics From Recent Multi-Spacecraft Observations

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Please see abstract paper number SM31D-01 for the complete abstract.