Kinetic Alfven Waves and associated Ion Heating in 3-D Magnetic Reconnection

Yu Lin
Physics Department, Auburn University, Auburn, AL, USA.

Shear Alfvén waves are believed to be fundamentally important in magnetic reconnection. Kinetic dynamics of particles can break the Alfvén speed limit in the evolution and propagation of perturbations during reconnection. In this talk, the generation and signatures of kinetic Alfvén waves (KAWs) associated with magnetic reconnection in a current sheet is investigated using a three-dimensional (3-D) hybrid code under a zero or finite guide field. The KAWs are identified using the wave dispersion relation, electromagnetic polarization relations, as well as spectral analysis. These KAWs are generated from the X line and coexist with the whistler structure of the ion diffusion region. They propagate along the magnetic field lines, carrying parallel electric field and Poynting fluxes. Dependence of the structure of KAWs on the guide field is investigated. By examining the ion dynamics associated with the KAWs generated during reconnection, it is found that an accelerated ion beam forms in the direction of the anti-parallel magnetic field, in addition to the core ion population, leading to a non-Maxwellian velocity distribution containing a trapped population with parallel velocities ~ the KAW wave speed. In the parallel direction, heating occurs from nonlinear Landau resonance of the trapped ions. In the perpendicular direction, evidence of stochastic heating by the KAWs is found during the acceleration stage. The parallel and perpendicular heating of the accelerated beam occur simultaneously. In the later stage, interaction between the accelerated beam and the core population also contributes to the ion heating, ultimately leading to an overall anisotropy with $T_{\|}>T_{\perp}$.