

Dispersive Alfvén Wave Instabilities Due to Sheared Field-Aligned Current

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The linear and nonlinear evolution of dispersive Alfvén waves (DAW) characterized by the electron inertial length and the sound gyroradius is discussed. Bounded Alfvén waves carry parallel current that is transversely sheared. The current shear is a driver for a robust class of instabilities that lower the magnetic energy through the advection of the parallel current in a manner that relaxes the current gradient. The magnetic energy is predominately transferred to transverse flow energy ultimately increasing the ion kinetic energy. Three subclasses of instability have been identified and studied extensively. These are the single tearing mode, the double tearing mode and the current-convective interchange mode. Magnetic reconnection is associated with all three modes and occurs due to finite electron inertia and is significantly enhanced by electron pressure. The results from three-dimensional two-fluid and PIC simulations show that the characteristics of the interchange mode is similar to satellite observations of broad-band extremely low frequency noise (BBELF). In particular, the $\delta E/\delta B$ spectrum follows that of the linear DAW result well into the nonlinear regime. We will discuss the basic linear and nonlinear physics of this magnetic energy relaxation process and present results from simulations. We propose that this process is fundamental to the decay of field-aligned currents existing near the dispersive scales and the transverse ion energization associated with BBELF.