Studies of nonlinear processes associated with Alfvén and drift-Alfvén waves in LAPD: nonlinear interactions, heating and turbulence

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Electromagnetic turbulence is thought to play an important role in plasmas in astrophysical settings (e.g. the interstellar medium, accretion disks) and in the laboratory (e.g. transport in magnetic fusion devices). From a weak turbulence point of view, nonlinear interactions between shear Alfvén waves are fundamental to the turbulent energy cascade in magnetic turbulence. Motivated by this, experiments on large amplitude Alfvén waves and their interactions are being carried out on the the Large Plasma Device (LAPD) at UCLA. LAPD is a 17m long, 60cm diameter, uniformly magnetized, cylindrical plasma column which supports Alfvén waves. Large amplitude Alfvén waves ($\delta B/B \sim 1\%$) are generated either using a resonant cavity (the Alfvén wave MASER[1]) or loop antennas. Earlier experiments revealed a nonlinear beat-wave interaction between copropagating kinetic Alfvén waves [2]. More recently, the focus of experiments has been on heating, background density modification and electron acceleration associated with single large amplitude Alfvén waves. Strong, localized electron heating is observed, localized to the wave current channels. In addition, depletion of the background density and modification of plasma potential are observed in the wave current channel at high amplitude. This localized modification of the background plasma results in changes in the spatial pattern of the incident Alfvén wave but also leads to secondary instabilities. The heating results in significant gradients in the electron temperature which in turn excite unstable drift-Alfvén waves. These drift-Alfvén waves then interact with the initial Alfvén wave, leading to sideband generation and spectral broadening. This may represent an alternate mechanism by which unidirectional Alfvén waves could generate a turbulent spectrum. Evidence for electron acceleration by the waves is also observed in these experiments. Details of these experimental observations will be discussed, as well as future plans for studies of nonlinear processes associated with Alfvén waves in LAPD.

[1] J.E. Maggs and G.J. Morales, Phys. Rev. Lett. **91**, 035004 (2003)
[2] T.A. Carter, B. Brugman, *et. al*, Phys. Rev. Lett. **96**, 15501 (2006)