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Experimental studies of Alfvén waves

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Shear Alfvén waves are generated by low frequency ($f < f_{ci}$) currents in magnetized plasmas. They and their cousins (the fast wave) are abundant in the solar wind, the earth's auroral plasma, planetary magnetospheres and fusion plasmas. Alfvén waves could play a role in remediation of energetic electrons trapped in the earth's radiation belts. Toroidal Alfvén eigenmodes are generated by fast particles in Tokomaks and can affect plasma confinement. Alfvén waves have been generated when high power lasers strike targets embedded in background magnetoplasmas [1]. In the ideal MHD limit the shear wave dispersion relation is simple but that evaporates when kinetic effects are included. In these circumstances the shear wave has an electric field parallel to the background magnetic field, is subject to Landau damping, can exhibit complex spatial morphology and propagation effects in non-uniform plasmas. Shear waves have large parallel wavelengths which dictate that lengthy magnetized plasmas are required to observe them. One such machine is the Large Plasma Device (LAPD) at UCLA. In this talk we review past experiments which mapped wave propagation and current systems associated with the wave in three dimensions[2]. Shear waves were studied in regimes where the wave phase velocity was greater than the electron thermal velocity (kinetic regime) and in the opposite inertial regime. Field aligned electrons in narrow oscillating currents $d \simeq c / \omega_{pe}$ generate Alfvén cones which have been studied extensively[3]. Waves generated from current loops and other structures are built from superposition of cones. Recent work in high β plasmas below and above f_{ci} show the effects of enhanced ion and electron temperatures and can be used as a diagnostic. Shear waves have been used to destroy 100 keV-1 MeV mirror trapped electron rings. Specialized antennas [4] have been used to generate high $k_\perp$ Alfvén waves and lattices of waves [Fig 1] .

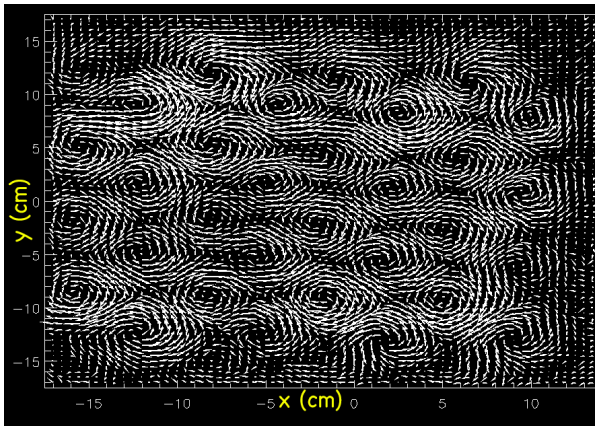

Figure 1. Transverse magnetic field of an Alfvén wave lattice. The wave was launched with a specialized antenna 4.88 m downstream. The background field was 500G, and the launch frequency 115 kHz

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