Dispersive Alfvén Waves in the Laboratory and Space

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Shear Alfvén waves play a significant role in several regions of near-Earth space including the plasma sheet, magnetopause, and auroral zone. The interesting physics occurs when the waves have narrow perpendicular structure of the order of the ion acoustic gyroradius or the electron skin depth. We discuss two sets of Alfvén wave studies, one from space and one from the laboratory. In space, prior work has shown that Alfvén waves can directly accelerate electrons to auroral energies and that these electrons can show a characteristic time dispersion in which the highest energy electrons arrive first, followed by lower energy electrons. However, rocket measurements have shown that this time dispersed signature can also occur simultaneously with monoenergetic electrons usually associated with quasi-static auroral acceleration. These observations can be explained by a mix Alfvén wave interactions in which the primary, monoenergetic electrons are *decelerated* by the wave parallel electric field and trapped, backscattered electrons are accelerated by the wave. From the laboratory, measurements of the shear Alfvén wave dispersion relation are reported for waves in the inertial, kinetic, intermediate regimes. The measurements were performed using the LArge Plasma Device at UCLA with the University of Iowa Arbitrary Spatial Waveform antenna. Examples of the kinds of waveforms which can be generated are shown to demonstrate the flexibility of the system. By comparing the arrival times of the waves at spatially separated points, the wave phase velocity is determined and then compared to the theoretical dispersion relation for all three regimes. The dispersion relation shows the expected variation in parallel phase velocity with increasing perpendicular wave number. The best agreement between theory and experiment occurs for the warm plasma dispersion relation including collisional damping.