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Experiments on Shear Alfvén waves with large transverse wavenumbers

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Large perpendicular wave numbers cause shear Alfvén waves to develop large parallel wave electric fields. These waves are expected to develop nonlinear effects when the associated magnetic field fluctuations are on the order of $\delta B_\perp/B_0 \approx \lambda_\perp/(\tau V_A)$, where V_A is the wave velocity. Here τ is the wave period and $\delta B_\perp$ is the Alfven wave magnetic field, B_0 is the background field. To create waves in this regime a specialized antenna ("Alfvén tennis racket") was constructed and its performance will be discussed. The experiments were conducted in the Large plasma device at UCLA. The LAPD plasma is 18 long and 50 cm in diameter and the axial magnetic field 400G. The antenna have successfully generated two dimensional Alfvén vortices in planes transverse to B_0 with $k_\perp = 0.63$ cm^{-1}. Two type of secondary antennae were constructed to launch waves different $k_\perp$'s (See Fig1). When both are used simultaneously they produce counter-propagating waves. For a single antenna a pattern of Alfvén wave vortices were generated in a Helium plasma with measured $\delta B_\perp/B_0 \approx 1\%$ in the far field of the antenna. ($\lambda_\perp = 8$ cm, density = $1.25\text{X}10^{13}$ cm^{-3}, $\lambda_\| = 112.5$ cm, $V_A = 6.2\text{X}10^7$ cm^{-1}) . This is roughly 1/4 of the wave field necessary for nonlinearities. The wave field is diagnosed with 3-axis magnetic probes. Data was acquired at 3025 positions on each of five planes transverse to the background field and at 8192 timesteps, dt = 80 ns. When two different antennas are simultaneously employed a host of wavenumbers not present when each antenna is independently energized are observed in the collision volume. Miniature test ion and electrons beams are under development to study chaotic particle motion.

This type of antennas will serve as a new platform to study large amplitude shear waves with large $k_\perp$.

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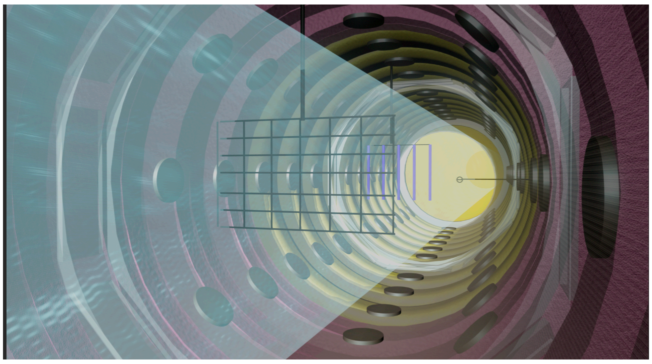

Fig 1. CAD drawing of the tennis racket and a 5 strut antenna in the LAPD device. The plasma column is represented in blue. A 3-axis magnetic field probe is shown on the right. The LaB_6 cathode at emission temperature is shown at the rear. The inner diameter of the chamber is 1 meter. A number of ports are visible

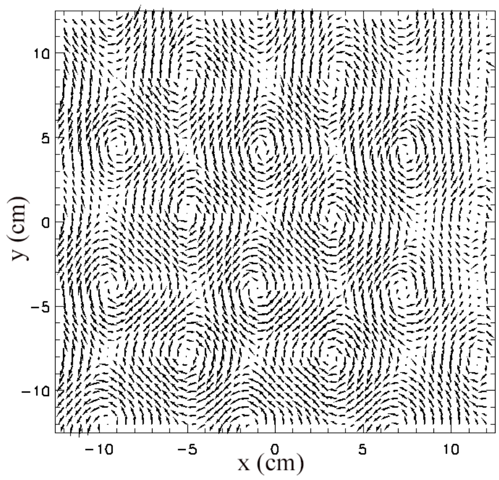

Fig. 2. Measured vector magnetic field, Bx-By on a plane 32 cm from the tennis racket antenna. This produced wavenumbers $(k_x,k_y) = 0.79$ cm^{-1}