Laboratory Studies on the Nonlinear Interactions of Kink-Unstable Flux Ropes and Shear Alfvén Waves

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Interactions between the kink oscillations and the shear waves can arise, and may even lead to nonlinear phenomena. Experiments aimed at elucidating such interactions are performed in the upgraded Large Plasma Device (LAPD) at UCLA. Flux ropes are generated using a 20 cm x 20 cm LaB_6 cathode-anode discharge (with L = 18 m and $\beta \sim 0.1$.) The ropes are embedded in a larger, otherwise current-free, cylindrical ($r = 30$ cm) ambient plasma produced by a second cathode. Shear Alfvén waves are launched using externally fed antennas having three separate polarizations (azimuthal mode numbers, m) The counter-propagating, kink-unstable oscillations and driven shear waves are observed to nonlinearly generate sidebands about the higher, shear wave frequency (evident in power spectra) via three-wave coupling. This is demonstrated though bi-coherence calculations and k-matching. With a fixed kink-mode polarization, a total of six daughter wave patterns are presented. Energy flow is shown to proceed from larger to smaller perpendicular wavelengths. The bi-coherence calculations show that as much as 60 % of the power observed in a sideband mode is a direct result of a quadratic interaction between the Alfvén wave and the kink oscillation. Future work will focus on increasing the plasma beta and wave amplitudes in the quest to observe an evolution to a turbulent state.
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