Nonlinear interactions of kink-unstable flux ropes and shear Alfvén waves

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Magnetic flux ropes and shear Alfvén waves occur simultaneously in plasmas ranging from solar prominences, the solar wind, and the earth's magnetotail. If the flux ropes evolve to become unstable to the kink mode, 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 at UCLA. Flux ropes are generated using a 20 cm $\times$ 20 cm LaB_6 cathode discharge (with $L \leq 18$ m and $\beta \sim 0.1$.) The ropes are embedded in an otherwise current-free, cylindrical ($r = 30$cm) ambient plasma produced by a second, BaO cathode. Shear Alfvén waves are launched using externally fed antennas. 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. Informational complexity and entropy of the time series are also investigated. Future work will focus on antenna-launched waves to control amplitude and frequency, as well as a possible evolution to a turbulent state.

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