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Turbulence and transport from multiple entangled electron temperature filaments in a magnetized plasma

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Steep thermal gradients in a magnetized plasma can induce a variety of spontaneous low frequency excitations such as drift-Alfven waves and vortices. We present results from basic experiments on heat transport in magnetized plasmas with multiple heat sources in close proximity [1]. The experiments were carried out at the upgraded Large Plasma Device (LAPD) operated by the Basic Plasma Science Facility at the University of California, Los Angeles. The setup consists of three biased probe-mounted CeB6 crystal cathodes that inject low energy electrons along a strong magnetic field into a pre-existing cold afterglow plasma forming three electron temperature filaments. A triangular spatial pattern is chosen for the thermal sources and multiple axial and transverse probe measurements allow for determination of the cross-field mode patterns and axial filament length. When the three sources are placed within a few collisionless electron skin depths, a non-azimuthally symmetric wave pattern emerges due to the overlap of drift-Alfven modes forming around each filament. This leads to enhanced cross-field transport from nonlinear convective (E×B) chaotic mixing and rapid density and temperature profile collapse in the inner triangular region of the filaments. Steepened thermal gradients form in the outer triangular region, which spontaneously generates quasi-symmetric, higher azimuthal mode number drift-Alfven fluctuations. A steady-current model with emissive sheath boundary predicts the plasma potential and shear flow contribution from the sources. A statistical study of the fluctuations reveals amplitude distributions that are skewed which is signature of intermittency in the transport dynamics.

[1] R.D. Sydora, S. Karbashewski, B. Van Compernolle, and M.J. Poulos, and J. Loughran, "Drift-Alfven fluctuations and transport in multiple interacting magnetized electron temperature filaments", Journal of Plasma Physics, vol. 85, issue 6, 2019, pp. 905850612.

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