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TH/P6-19: Application and Development of the Gyro-Landau Fluid Model for Energetic-particle Instabilities

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Reduced dimensionality models for energetic particle (EP) instabilities [1,2] provide good computational efficiency in simulation of EP-destabilized shear Alfvén modes through the use of Landau-fluid closure methods. This allows rapid testing of profiles and parameter variations and can facilitate understanding experimental results when not all quantities are precisely measured. The recent applications of this model (TAEFL) are the topic of this paper and include: RSAE to TAE frequency upsweep transitions [3] in DIII-D advanced tokamak (reversed q-profile) regimes, antenna-based Alfvén damping measurements in JET [4], ITPA-EP benchmark studies, and ITER alpha and beam-driven instabilities [5]. The non-perturbative nature of this model is evident in the up-down MHD parity-breaking twist of the mode structures predicted for reversed shear q-profiles. Such characteristics are now measured experimentally [4], and provide a signature of the kinetic destabilization of these modes. Techniques have also been developed to extend the TAEFL model to more general forms of fast ion velocity distribution; by including two additional moments (parallel temperature and heat flux) slowing-down distributions, anisotropic Maxwellians and distributions with hole-clump perturbations can be modeled. Two further recent improvements in the TAEFL Landau closure are the coupling of sound waves and an extension of the existing tokamak initial value solver to an eigenvalue model that can treat both axisymmetric and 3D equilibria. The acoustic coupling effects were essential for modeling upsweeping RSAE mode frequencies.

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