Kinetic Structure of Low Frequency Continuous Spectrum in General Tokamak Geometry

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The low frequency kinetic continuous spectra of shear Alfvén waves (SAW) and ion acoustic waves (IAW) in magnetic confinement devices are widely used for identification of frequency gaps and discrete modes. The drift Alfvén energetic particle stability (DAEPS) code [1], which is an eigenvalue code using the finite element method, is used to calculate the low frequency fluid and kinetic continuous spectra. The model equations, consisting of quasi-neutrality condition and Schrödinger-like form of vorticity equation, are derived within the general fishbone-like dispersion relation (GFLDR) theoretical framework [2, 3]. The mode structure decomposition approach and asymptotic matching between the inertial/singular layer and ideal regions are adopted. In this work, the numerical model of the DAEPS code is further extended to include general axisymmetric geometry. Numerical results of fluid and kinetic continuous spectra are benchmarked with FALCON [4] and LIGKA [5, 6], respectively. The comparison of circular (model) and experimental ITER profiles shows that the structure of the kinetic continua is sensitive to the shaping effect. Comparing kinetic and MHD continuous spectra also suggests that the structure of the kinetic and MHD continua share a similar frequency behavior, while the damping rate of the kinetic continua reflects the SAW/IAW coupling and/or the polarization of the fluctuation structure. It is also suggested that the ion diamagnetic frequency, corresponding to the plasma nonuniformity, not only changes the frequency, but also destabilizes the kinetic ballooning mode/Alfvén ITG branch near the accumulation point. The use of DAEPS as building block of a hierarchy of reduced energetic particle transport models, which are presently being developed, will also be discussed.

Reference:

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