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TH/P6-03: Electron Fishbone Simulations in FTU-like Equilibria Using XHMGC

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Internal kink instabilities exhibiting fishbone like frequency chirp down have been observed in a variety of experiments where a high energy electron population was present. The relevance of the electron fishbones is primarily related to the fact that suprathermal electrons are characterized by relatively small orbit width, when compared with those of fast ions, similarly to the case of alpha particles in burning plasmas: thus, electron fishbones offer the opportunity to study the coupling between energetic particles and MHD modes in burning plasma relevant conditions even in present machines. In fact, precession resonance depends on energy, not mass; meanwhile, suprathermal electron transport perpendicular to the equilibrium magnetic field caused by fishbones can reflect some properties of fluctuation induced transport of fusion alphas due to precession resonance. The nonlinear MHD-Gyrokinetic code (HMGC) has been recently extended (from which the name XHMGC) to include new physics, including both thermal ion compressibility and diamagnetic effects, and finite parallel electric field due to parallel thermal electron pressure gradient, which enters the parallel Ohm's law and generalizes it, accounting for the kinetic thermal plasma response. Moreover, XHMGC is now able to treat up to three independent particle populations kinetically, assuming different equilibrium distribution functions (as, e.g., bulk ions, energetic (ion and/or electrons) particles accelerated by NBI, ICRH, fusion generated alpha particles, etc.). We will refer to the typical parameters of the FTU machine, where electron fishbones appearance has occurred in Lower Hybrid heated discharges. The FTU-like equilibrium corresponds to a torus with circular shape cross section, with an inverse aspect ratio ˜0.3. The safety factor profile has been assumed slightly reversed. Energetic electrons, described by a strongly anisotropic Maxwellian distribution function (thus, retaining resonant excitation), and the bulk ions, described by isotropic Maxwellian (in order to account for thermal ion Landau damping and finite compressibility) will be treated kinetically. A detailed study of single particle resonant frequencies during linear phase of the mode will be presented, together with nonlinear dynamics characterization of single particle motion in phase space during mode saturation.

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