Poster TH/P4-6: Linear and nonlinear dynamics of electron fishbones

G. Vlad[1], V. Fusco[1], S. Briguglio[1], C. Di Troia[1], G. Fogaccia[1], F. Zonca[1,2], X. Wang[3]

[1]ENEA, Dipartimento FSN, C. R. Frascati, via E. Fermi 45, 00044 Frascati (Roma), Italy

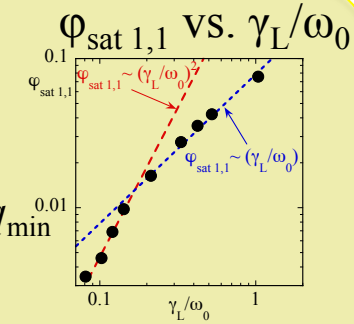
[2]IFTS and Department of Physics, Zhejiang University, Hangzhou 310027, People's Republic of China

[3]Max-Planck-Institut für Plasmaphysik, Boltzmannstrasse 2, D-85748 Garching, Germany

- Numerical simulations of electron fishbone using the hybrid MHD-Gyrokinetic code XHMGC
- XHMGC: Reduced $O(\varepsilon^3)$ MHD (bulk) + Gyrokinetic contribution from energetic electrons (Ee); also compressibility effects of thermal ions (to properly retain Landau damping and generalized inertia) and thermal electrons are retained kinetically.

Two cases considered:

- Radial density profile of energetic electrons **peaked on-axis**:
  - e-fishbone is observed above threshold in Ee density n_{Ee}, and driven by trapped Ee at toroidal precession frequency: $\omega_{res} = n\bar{\omega}_d$;
  - the mode rotates in the energetic (and bulk) electron diamagnetic velocity direction;
  - non linear dynamics: frequency chirping, phase locking, radial transport of Ee up to q_{min} radial position.
  - Electrostatic potential (φ) saturation amplitude scaling in agreement with analytical findings: $\varphi_{sat\ 1,1} \sim (\gamma_L/\omega_0)^2$; $\varphi_{sat\ 1,1} \sim (\gamma_L/\omega_0)$



- Radial density profile of energetic electrons **peaked off-axis**:
  - e-fishbone is observed above threshold in n_{Ee}, and driven by barely circulating Ee at frequency (ω_b is the transit frequency): $\omega_{res} = n\bar{\omega}_d - (n\bar{q} - m)\omega_b$;
  - the mode rotates in the Ee diamagnetic velocity direction (corresponding to the one of the bulk ions);
  - non linear dynamics: double resonance, local flattening of the radial density profile of the Ee at the double resonance radial locations.
  - Electrostatic potential saturation amplitude scaling: $\varphi_{sat\ 1,1} \sim (\gamma_L/\omega_0)^3$; $\varphi_{sat\ 1,1} \sim (\gamma_L/\omega_0)^{3/2}$