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TH/P6-21: Simulation of EPM Dynamics in FAST Plasmas Heated by ICRH and NNBI

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The Fusion Advanced Studies Torus (FAST) has been proposed as a possible European ITER Satellite facility, aimed at preparing ITER operation scenarios and experimentally studying burning plasma physics issues in deuterium plasmas.
The external heatings in the extreme H-mode scenario of FAST are supplied by NNBI (Negative Neutral Beam Injection) and ICRH (Ion Cyclotron Resonance Heating).
Energetic particles generated by NNBI and minority population from ICRH can excite meso-scale fluctuations. For this reason, FAST can investigate radial transport of energetic ions due to collective mode excitations with the same characteristics of those expected in reactor relevant conditions.
The supra-thermal minority population produced by ICRH is characterized by peaked off-axis density distribution and effective perpendicular Temperature profiles. Moreover, the minority particles move mainly on trapped orbits. The supra-thermal population from NNBI shows an average pitch angle correlated to the beam injection angle. In this latter case, most of the particles follow passing orbits, with an imbalance between co- and counter-passing orbits.
Those behaviors can be described with a recently proposed parametric equilibrium distribution function which depends only on the invariants of motion and constant parameters. These parameters are chosen to be consistent with profiles produced by FAST NNBI and ICRH systems, respectively characterized by 1 MeV beam energy with 10 MW power and antenna frequency between 80 MHz and 85 MHz with 30 MW power, typically deposited on Helium minority. The reconstructed FAST scenario is used for numerical simulation studies with XHMGC, a MHD-gyrokinetic code which allows to treat simultaneously different populations of energetic particles and describes the thermal plasma by low-beta nonlinear reduced MHD equations with circular shifted magnetic surface equilibrium.
Linear and nonlinear EPM (Energetic Particle driven Mode) behaviors are analyzed,retaining self-consistently the mutual interaction between waves and energetic particles. The roles played by fast particle characteristic frequencies and radial profiles in determining the Alfven fluctuation spectrum are studied and illustrated by detailed synthetic diagnostics.

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