The energy analysis of the nonlinear simulation about the EAST coherent mode

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The EAST coherent mode (CM) during inter-ELM phase in H-mode discharge is simulated by the electromagnetic six-field two-fluid module in BOUT++ framework. The fluctuation level of the electrostatic potential, electron pressure and density perturbations are comparable to the experiments, and the simulated electrostatic perturbation is more than two orders of magnitude larger than the magnetic one in EAST coherent mode. The energy transfer between three-wave coupling indicates that the energy tends to transfer from medium-n to low-n modes in early nonlinear phase, and the modes coupling effect in nonlinear saturation phase is larger than that in early nonlinear phase. Both the energy transfer and bispectral analysis show that the N_i fluctuation tends to generate the 'single-mode' coupling and T_e tends to be 'multiple-mode', which indicates that the collapse of density profile is larger than electron temperature. The relative phase analysis is applied to evaluate whether the turbulence can extract the energy from density and temperature profiles. The result indicates that the density profile provides much more energy to drive the turbulence than electron temperature. The kinetic and magnetic energy transfer rates are used to understand the instability and turbulence driving mechanisms of the EAST coherent mode. In the linear phase of the nonlinear simulation, the instability is driven by the peeling-ballooning mode and DAW, and the radial electric field and shear Alfven wave have large suppressing effects. The turbulence of EAST coherent mode is a predominantly electrostatic mode, which corresponds to the Reynolds stress that is about seven times larger than Maxwell stress. In addition, the effect of electrostatic part in DAW is much larger than the electromagnetic one.

Key words: Coherent mode, Energy transfer, Bispectral analysis, Relative phase, Kinetic and magnetic energy