6th Asia-Pacific Conference on Plasma Physics, 9-14 Oct, 2022, Remote e-conference

Coupling among neoclassical tearing modes, edge localized modes and Alfven eigenmodes in HL-2A high beta H-mode plasmas

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Multi-scale nonlinear interactions are ubiquitous and complicated, and several channels could be involved in high β H-mode plasmas [1-3], such as the macro-scale neoclassical tearing mode (NTM) and edge localized mode (ELM), meso-scale energetic particle (EP) driven modes and microscale turbulence.

In this work, several MHD modes, such as the NTM accompanied by the internal helical core, ELM and two branches of AEs (including the TAE and BAE), coexist in the HL-2A high beta H-mode plasmas. The intimate interaction among them and its impact on plasma properties are studied for the first time. The NTMs induce a saturated m/n=1/1 helical core (m and n are the poloidal and toroidal mode numbers, respectively) through the "magnetic-flux pumping" effect. The ELM crash results in a rapid (< 1 ms) decrease of the NTM island width followed by a much slower recovery. The degree of the island-width drop is proportional to the normalized beta as well as the ELM size, and can be up to 60%. In addition, two branches of AEs, in the toroidal Alfven eigenmode (TAE) and beta-induced Alfven eigenmode (BAE) bands, become evident after the 2/1 NTM onset and their magnitudes are modulated by the 2/1 NTM rotation. Besides, the changes of the TAE and BAE amplitudes are closely related to the temporal evolution of the ELM crash event, implying the strong interaction between AEs and the ELM. It is found that the coupling among these MHD modes in the core region during the NTM phase regulates the edge transport, i.e., relaxation of the pressure profiles, mitigation of the peeling-ballooning instability, reduction of the radial electric field shear and enhancement of the turbulent transport in the pedestal region. These new results provide significant implications on the control of the core MHD modes and their regulation on the edge transport, which are important issues in the future fusion reactors. Please see more details in Ref. [4].

References

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