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Suppression and destabilization of ion fishbone activities on HL-2A

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Magneto-hydrodynamic (MHD) instabilities in hot plasmas can strongly limit the operational parameter space of a fusion reactor. Their stabilization, suppression and active control have therefore attracted much attention, in particular with regard to expansion of the operational space, enhancing the fusion performance and decreasing the energetic particle losses in both present-day fusion devices and future devices with burning plasmas. Control of multiple instabilities including sawtooth, neoclassical tearing mode (NTM), resistive wall mode (RWM), edge localized mode (ELM), Alfven eigenmode as well as energetic-particle mode (EPM), has been successfully achieved, to various degrees, by different means such as the radio frequency wave heating/drive, the three-dimensional magnetic perturbations, and so on, in many fusion devices. On the other hand, understanding of both the control and physics of these instabilities, in many cases, is still far from complete, and remains area of active research. The fishbone mode is one of these key instabilities, which is destabilized by a population of energetic particles. In burning plasmas, energetic alpha particles, though being a minority species, carry a large fraction of the plasma kinetic energy, and can potentially drive the fishbone instability. The fishbone has also been proposed as a possible scheme for ash removal and burn control, as well as tungsten-impurities removing from the plasma core on ITER.
In this paper the recent progress of ion fishbone activities will be present on HL-2A. Firstly, it will be reported the stabilization of m/n=1/1 fishbone by ECRH. The stabilization of m/n=1/1 fishbone depends not only on the injected power but also on the radial deposition location of ECRH, and the instability can be completely suppressed when the injected ECRH power exceeds certain threshold. Analysis by the fishbone dispersion relation, including the resistive effect, suggests that the magnetic Reynolds number plays a key role in the mode stabilization. Secondly, it will be introduced the destabilization of m/n=2/1 fishbone. The evolution of m/n=2/1 fishbone is related to mode rotation reverse. The excitation mechanism of m/n=2/1 fishbone will also be discussed, namely what's the result of the kink or tearing mode interacting with circulating or trapped EPs.

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