Experimental Observation of Multi-scale Interactions in the HL-2A Core NBI Plasmas

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Multi-scale interactions are important components of complex dynamics in fusion plasmas. They can produce different scale structures, determine their excitation/saturation/damping, transfer wave energy among different scale structures, and finally, affect the plasma confinement/transport. They are believed to link to ITB formation, L-H transition, bifurcation phenomenon and collapse event in fusion plasma[1, 2, 3, 4]. To unravel the underlying physics mechanism of them, studies of multi-scale physics including observation, modeling and simulation, are needed urgently.

In the HL-2A core NBI plasmas, multi-scale interactions had been observed clearly, including the synchronous coupling between m/n=1/1 kink mode and m/n=2/1 tearing mode, nonlinear couplings of TAE/BAE and m/n=2/1 TM at q=2 surface[5], AITG/KBM/BAE and m/n=1/1 kink mode at q=1 surface, and between m/n=1/1 kink mode and high-frequency turbulence. Experimental results suggest that several couplings can exist simultaneously, such as kink and tearing mode, kink and AITG/KBM/BAE, kink and high-frequency turbulence. Alfvenic fluctuations have an important contribution to the high-frequency turbulence spectra. The couplings reveal the electromagnetic character but not the pure electrostatic. Multi-scale interactions via the nonlinear modulation process maybe enhance plasma transport and trigger sawtooth-crash onset, and it is a big challenge for the multi-scale physics and simulation.

References


