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Frequency slowly-sweeping Alfvenic modes on the HL-2A tokamak

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Experimental investigations of frequency slowly-sweeping Alfvenic modes have been carried out on the HL-2A Tokamak. There are two different kinds of instabilities in the neutral beam heated plasma, i.e., the typical reversed shear Alfven eigenmodes (RSAEs) and the high modes with frequency slowly sweeping from 500kHz to 100kHz. On one hand, the RSAEs are driven unstable by the passing fast ions and locate nearby the q=1 rational surface. The most unstable toroidal mode numbers are n= 2-3 for the up-sweeping RSAEs while n=2-6 for the down-sweeping modes. The nonlinear chirping behaviours of RSAEs, i.e. the pitch-forks have been observed during second half of sawtooth periods. The kinetic drive and intrinsic damping rate are around 9.2 × 103 s −1. But when RSAEs appear together with TAEs, the symmetry of pitch-forks break down. As a result, the upper and down branches evolve with different drives and damps. Besides, the Alfvenic activities are proved to degrade the bremsstrahlung radiations and lead to reduces of ion temperature in the core plasma. It is because the RSAEs resonant with thermal ions, and then lead to a heat transport process. Statistical results suggest there is a quadratic dependence between thermal ion heat flux perturbation and mode amplitude, which indicates a diffusive mechanism of plasma transport and is well explained by the theoretical interpretations derived from quasi-linear transport theory. On the other hand, the high frequency modes are usually driven unstable in the high density discharges. The mode frequency ranges 100-500kHz and passes through the toroidal and ellipticity-induced continuum gap. There being no direct relationship have been found between frequency evolution and safety factor, though the high frequency modes show a RSAE-like behaviours. The instability can transform into multiple discrete modes during the slowly down-sweeping period. Interestingly, narrow electron density internal transport barrier can be observed by the frequency modulated continuous wave reflectometer when the high frequency modes appear, which indicates a possible particle transport process. However, the underlying excitation mechanism of high frequency mode remains unresolved now and more attentions should be paid to. The results presented here may contribute to better understandings for the wave-particle interactions and subsequent energy or particle transport induced by energetic ions driven magnetohydrodynamic instabilities in fusion devices.

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