Contribution ID: **527** Type: **Poster**

Simulation of Toroidicity-Induced Alfven Eignenmode Excited by Energetic Ions in HL-2A Tokamak Plasmas

Tuesday, 23 October 2018 14:00 (20 minutes)

The toroidicity-induced Alfven eigenmode (TAE) excited by energetic ions was first simulated by using GTC code based on HL-2A experimental configuration. The simulation results show that the fraction of energetic (fast) ions in HL-2A experiments is about 3%. The TAE eigenmode frequency is around 211 kHz and is inversely proportional to the square root of electron density, which is quantitatively in agreement with the experimental observation. The real frequency of TAE modes increases with both temperature of energetic ions (beam energy) and toroidal model numbers increasing thanks to the toroidal precession resonance is dominant, but almost keeps constant when the density of energetic ions changes. The growth rates of TAE modes increase with increasing density as well as density gradient of fast ions. The amplitude of the vector potential A// exponentially increases with time for linear TAE mode. Besides, the low n (toroidal mode number) TAE modes, such as n=1 can also be driven by energetic ions when off-axis heating with higher beam energy is employed during HL-2A NBI experiment. The half width of radial mode structures for low n modes is usually wider than those for high n modes. The perpendicular wave vector of the TAE modes and Larmor radius of ions satisfy the relation . At the same time, the polarization of the TAE mode shows that the perturbed parallel electric field is zero. Thus, the TAE mode is close to an ideal MHD mode.

Country or International Organization

China, People's Republic of

Paper Number

TH/P2-3

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Session Classification: P2 Posters