Stochastic heating of thermal ions by compressional Alfvén eigenmodes in NSTX

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In neutral beam heated discharges in NSTX, the observed ion temperature is sometimes higher than what could be expected from the balance between collisional heating due to the fast ions and losses caused by transport and collisions with electrons. At the moment when the beams are switched on, the ion temperature can also rise to these high levels on time scales shorter than the slowing-down time of the fast ions, which implies that there exists a source of heating in excess of the collisional beam ion heating. It has been proposed \cite{Gates2001} that this heating originates from interaction with compressional Alfvén eigenmodes (CAEs) \cite{Gorelenkov1995}, which are commonly observed in beam heated discharges. In this model, the energy is transferred from the fast ions to the waves by resonance, and from the waves to the thermal ions by stochastic heating. The latter is a non-resonant process, which is possible in these discharges because several Alfvén eigenmodes occur simultaneously at around half the ion cyclotron frequency when the beams are turned on \cite{Chen2001}.

In the present study, we model the process quantitatively, to assess if the proposed heating mechanism can supply the excess heating inferred from transport modeling. The spatial structure of the CAEs is determined with an eigenmode code \cite{Smith2009} and the CAE amplitudes are obtained from density fluctuations measurements with the high-k diagnostic. A large number of thermal ions are tracked in the full gyro-orbit code Gyroxy \cite{White2002} under influence of the eigenmodes, and the evolution of the kinetic energy is monitored. The registered heating is then compared with energy balance calculations for the chosen discharge with the Transp code \cite{Goldston1981}.

References


