Subject Area: B.2 Theoretical and computer modeling in Equilibrium and stability

Kinetic Effects on MHD Modes in NSTX

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Particle kinetic effects such as finite ion gyroradii, trapped particle dynamics and wave-particle resonances can greatly modify MHD phenomena. In particular, trapped particle effects are significant in low aspect ratio devices, and we will show that the kinetic effects of trapped electron dynamics and ion Larmor radii can give rise to a large stabilizing effect on kinetic ballooning modes (KBMs). The stabilizing effect is due to an enhanced parallel electric field and hence a parallel current that enhances the stabilizing field line tension by a factor proportional to the ratio of the total electron density to the untrapped electron density. Since the Alfven continuum gap increases due to stronger toroidal coupling in low aspect ratio devices, more TAEs can exist. We present the analysis of TAEs destabilized by fast NBI ions in NSTX experiments. To model the kinetic effects on MHD phenomena, we present a kinetic-fluid model, which consists of single-fluid equations coupled with kinetic (gyrokinetic or full orbit
Vlasov) descriptions for all particle species via pressure tensors. In the linear limit, we show that the kinetic-fluid model properly retains key physics of both thermal and energetic particles for global MHD modes. The kinetic-fluid model is a natural extention of the previously developed kinetic-MHD model, which has been successfully employed to build global linear and nonlinear kinetic-MHD codes for modeling fast ion driven modes.