Global Gyrokinetic Simulations of Electromagnetic Instabilities in Tokamak Plasmas

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Gyrokinetic simulation is now recognized as an important tool for studying Alfvenic modes in tokamak plasmas, especially taking into account the role of energetic particles in exciting electromagnetic instabilities. The cutting-edge global nonlinear gyrokinetic particle-in-cell code GTC has been modified to include independent energetic ion species and electromagnetic capabilities. The fluid-kinetic hybrid electron model has been implemented to separate the electron response into lowest order adiabatic and high-order drift-kinetic parts, which significantly increases the numerical efficiency. Linear benchmarks of toroidal Alfven eigenmode (TAE), reversed-shear Alfven eigenmode (RSAE), and beta-induced Alfven eigenmode (BAE) excited by antenna and driven by energetic particles have been performed. The RSAE-TAE transition by varying the minimum of the safety factor has been demonstrated. The nonlinear BAE frequency fast chirping has been observed for the first time in gyrokinetic simulation. Simulations of ideal and kinetic ballooning modes have also been performed to study their roles in tokamak edge transport and pedestal dynamics. The work is supported by DOE SciDAC GSEP center.