Contribution ID: **69** Type: **Oral**

Verification and validation of gyrokinetic and kinetic-MHD simulations for internal kink and fishbone instabilities in DIII-D and ITER

Monday, 6 December 2021 16:20 (20 minutes)

Verification and validation of the internal kink instability in tokamak have been performed for both gyrokinetic (GTC) and kinetic-MHD codes (GAM-solver, M3D-C1-K, NOVA, XTOR-K). Using realistic magnetic geometry and plasma profiles from the same equilibrium reconstruction of the DIII-D shot \#141216, these codes exhibit excellent agreements for the growth rate and mode structure of the n=1 internal kink mode in ideal MHD simulations by suppressing all kinetic effects. The simulated radial mode structure agrees quantitatively with the electron cyclotron emission measurement after adjusting, within the experimental uncertainty, the q=1 flux-surface location in the equilibrium reconstruction. Equilibrium plasma pressure gradient and compressible magnetic perturbation strongly destabilize the kink, while poloidal variations of the equilibrium current density stabilize the kink. Furthermore, kinetic effects of thermal ions are found to decrease the kink growth rate in kinetic-MHD simulations, but increase the kink growth rate in gyrokinetic simulations, due to the additional drive of the ion temperature gradient and parallel electric field. Kinetic thermal electrons are found to have negligible effects on the internal kink instability.
The validated MHD capability of GTC is then applied to study the NBI/alpha fishbone instability in ITER plasmas. Fishbone modes are found unstable for a pre-fusion baseline and 15 MA steady-state scenarios. DIII-D discharges similar to the ITER scenarios have been identified to validate GTC simulation results. Fishbone modes are found unstable in these DIII-D plasmas as well, with similar mode structures to those found in ITER simulations.

Speaker's Affiliation

University of California, Irvine

Member State or IGO

United States of America

Primary authors: BROCHARD, Guillaume (University of California, Irvine); BAO, Jian (Institute of Physics, Chinese Academy of Sciences); LIU, Chang (Princeton Plasma Physics Laboratory); GORELENKOV, Nikolai (PPPL, Princeton University); CHOI, GYUNGJIN; Dr DONG, Ge (Princeton Plasma Physics Laboratory); Dr LIU, Pengfei (University of California Irvine); MCCLENAGHAN, Joseph (General Atomics); NICOLAU, Javier H (University of California); WANG, Feng (School of Physics, Dalian University of Technology); WANG, Wenhao (University of California, Irvine); ZHANG, wenlu (institute of physics, chinese academy of sciences); HEIDBRINK, William; GRAVES, Jonathan (Ecole Polytechnique Federale de Lausanne (EPFL), Swiss Plasma Center (SPC), CH-1015 Lausanne, Switzerland); LIN, Zhihong (UC Irvine); LÜTJENS, Hinrich (Centre de Physique Théorique, Ecole Polytechnique, CNRS)

Presenter: BROCHARD, Guillaume (University of California, Irvine)

Session Classification: Effects of Energetic Particles in Magnetic Confinement Fusion Devices

Track Classification: Effects of Energetic Particles in Magnetic Confinement Fusion Devices