Contribution ID: **243** Type: **Poster**

Gyrokinetic simulations of electrostatic microinstabilities with bounce-averaged kinetic electrons for shaped tokamak plasmas

Wednesday, 19 October 2016 08:30 (4 hours)

Nonlinear bounce-averaged kinetic theory[B.H. Fong and T.S. Hahm, Phys. Plasmas 6, 188 (1999)] is used for magnetically trapped electrons for the purpose of achieving efficient gyrokinetic simulations of Trapped Electron Mode (TEM) and Ion Temperature Gradient mode with trapped electrons (ITG-TEM) in shaped tokamak plasmas. Bounce-averaged kinetic equations are explicitly extended to shaped plasma equilibria from the previous ones for concentric circular plasmas, and implemented to a global nonlinear gyrokinetic code, Gyro-Kinetic Plasma Simulation Program (gKPSP)[J.M. Kwon et al., Phys. Plasmas 21, 013004 (2012)]. Verification of gKPSP with bounce-averaged kinetic trapped electrons in shaped plasmas is successfully carried out for linear properties of ITG-TEM mode and Rosenbluth-Hinton residual zonal flow[M.N. Rosenbluth and F.L. Hinton, Phys. Rev. Lett. 80, 724 (1998)]. Physics responsible for stabilizing effects of elongation on both ITG mode and TEM is identified using global gKPSP simulations. These can be understood in terms of magnetic flux expansion leading to the effective temperature gradient R/L_T(1-E')[P. Angelino, et al., PRL 102, 195002 (2009)] and poloidal wave length contraction at low field side resulting in the effective poloidal wave number k_theta*rho_i/kappa.

Paper Number

TH/P3-4

Country or International Organization

South Korea

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Session Classification: Poster 3

Track Classification: THC - Magnetic Confinement Theory and Modelling: Confinement