Verification of Fast Ion Effects on Turbulence through Comparison of GENE and CGYRO with a L-mode Discharge in KSTAR

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We conducted a code verification study to investigate the effects of fast ions on turbulence by comparing two gyrokinetic codes: GENE [F. Jenko *et al.*, *Phys. Plasmas* **7**, 1904-1910 (2000)] and CGYRO [J. Candy *et al.*, *J. Comput. Phys.* **324**, 73-93 (2016)]. Using L-mode plasma profiles from KSTAR, we performed local linear and nonlinear electromagnetic simulations to systematically assess the impact of fast ions and rotation effects on energy flux through ablation tests. The two codes demonstrated consistent results in linear stability analysis, absolute levels of fast ion energy flux, fractional changes in energy flux due to fast ions, and the distribution of energy flux, fluctuations and their phase angles, as well as the zonal flow shearing rate when rotation effects were included. However, notable discrepancies were observed, including inconsistent predictions of absolute thermal energy flux levels, fractional changes in zonal shearing rates caused by fast ions without rotation effects, and the impact of rotation on energy transport, which became more pronounced in the presence of fast ions. The study also underscores the critical role of phase angle between potential and energy fluctuations in understanding fast ion effects on turbulence. These findings identify the direction for future verification studies, including the need for further investigation into these discrepancies and the phase angle changes, which will advance predictive capabilities for accurate transport modeling in future burning plasmas.