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Gyrokinetic XGC1 Simulation Study of Magnetic Island Effects on Neoclassical and Turbulence Physics in a KSTAR Plasma

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We perform gyrokinetic simulations to study the effects of a stationary magnetic island on neoclassical and turbulence physics. A KSTAR L-plasma condition is employed for the simulations. Through the simulations, we aim to understand the underlying physical mechanisms of poloidal flows and fluctuations around a stationary (2,1) magnetic island, which were observed in a recent KSTAR experiment using 2D ECEI diagnostics [M.J. Choi et al., Nucl. Fusion 57, 126058 (2017)]. From the simulations, it is found that the magnetic island can significantly enhance the equilibrium ExB flow. The corresponding flow shearing is strong enough to suppress a substantial portion of ambient micro-instabilities, particularly ∇T_e-driven trapped electron modes. This implies that the enhanced ExB flow can sustain a quasi-internal transport barrier for T_e in an inner region neighboring the magnetic island. The enhanced ExB flow has a (2,1) mode structure, which shows a finite phase difference with the mode structure of the magnetic island. It is shown that the flow shear and fluctuation suppression patterns the simulations imply are consistent with the ECEI observations on the KSTAR experiment.

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