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Multi-Machine Analysis of Turbulent Transport in Helical Systems via Gyrokinetic Simulation

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As a trial in evaluating helical system designed with different concepts, we have compared two devices, the Large Helical Device (LHD) and the Heliotron J (HJ), with different magnetic field structure under two key parameters, i.e. the Mercier/interchange measure D_well and the magnetic shear s_hat, focusing on their linear drift wave instability and nonlinear evolution leading to turbulent transport. Here, the neoclassically optimized LHD is magnetically "hill" with moderate shear (D_well, s_hat)=(-0.01, 1.2) while the HJ "well" with extremely small shear (0.7, 0.02). We found a reciprocal relation between linear stability and nonlinear turbulence as that the device with smaller magnetic shear, which exhibits larger linear growth rate for the ITG mode, i.e. the HJ, provides smaller turbulent transport nonlinearly than that in the LHD due to larger production rate of zonal flows. The neoclassical optimization improves the turbulent transport in the HJ as well as the LHD. This suggests that the concept in optimizing Mercier/interchange mode and also neoclassical transport can be compatible with that in reducing turbulent transport.

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