Distinct turbulence sources and confinement features in spherical tokamak plasma regime

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Highly distinct features of spherical tokamaks (ST) such as NSTX/U result in a different fusion plasma regime with unique physics properties compared to conventional tokamaks. Nonlinear global gyrokinetic simulations critical for addressing turbulence and transport physics in ST regime have led to new insights regarding non-traditional turbulence sources contributing to plasma transport and confinement in ST experiments. The drift wave Kelvin-Helmholtz (KH) instability characterized by intrinsic mode asymmetry is identified in strongly rotating NSTX L-mode plasmas. For the first time, the KH mode is shown as a driver of significant transport in realistic fusion experiments. Also for the first time, long wavelength, quasicoherent dissipative trapped electron modes are found to be excited over a wide range of NSTX parameter regime despite the presence of strong $\mathbf{E} \times \mathbf{B}$ shear, providing a robust turbulence source dominant over the traditional collisionless trapped electron modes in ST plasmas. Furthermore, DTEMdriven transport in NSTX parametric regime is shown to increase with electron collision frequency, offering one possible source for the confinement scaling observed in experiments. More interestingly, the existence of a minimum plasma transport regime that future advanced STs may access is predicted. This work was supported by U.S. DOE Contract DE-AC02-09CH11466.