The local magnetic field scaling of gyrokinetic turbulence and its impact on tokamak transport

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Gyrokinetic turbulence simulations with the CGYRO [1] and GENE [2] codes were performed in order to investigate the dependence of the turbulent transport on flux surface Shafranov shift and elongation. Gyrokinetic codes use a reference magnetic field to normalize the equations but the energy flux in SI units does not depend on the reference magnetic field. The saturated electrostatic potential fluctuation intensity spectrum at the outboard midplane, and the overall changes in the energy fluxes were examined to determine the dependence on the elongation and Shafranov shift of flux surfaces. The satisfying physical result of this study is that the local total magnetic field determines the scaling of the radial correlation length of the turbulence, independent of the choice of magnetic field normalization. A modification of the saturation model used in TGLF [3], including these local scaling properties, is able to reproduce the gyrokinetic flux scaling well. The spectral shift model [4], for the impact on the intensity spectrum of equilibrium ExB velocity shear, was simplified by these new insights. These changes to TGLF yield a flux in SI units that decreases with elongation to the first power rather than elongation squared. The slope of the reduction of the energy flux in SI units with ExB velocity shear does not increase as strongly with elongation or Shafranov shift with the new TGLF model. The dependence of the TGLF saturation model on Shafranov shift was also modified to fit the gyrokinetic simulations. The impact of the modified saturation model on the TGLF prediction of plasma profiles of JET, DIII-D L-mode edge and high Shafranov shift discharges will be presented. This work was supported by the US Department of Energy under DE-FG02-95ER54309, DE-FC02-04ER54698, DE-SC0019736.

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