Theory Based Transport Modeling of ECRH Plasmas in HSX

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The improvement of core transport in the quasi-helically symmetric (QHS) configuration of HSX as compared to a configuration with the symmetry intentionally broken (Mirror) has recently been demonstrated [1]. This is largely due to the improvement of neoclassical transport via quasi-symmetry. However, under present operating conditions, the overall transport is anomalously large across most of the minor radius. Furthermore, it is unclear if there are significant differences in the anomalous transport owing to quasihelical symmetry.

To test whether available transport models can reproduce the anomalously large transport in HSX, the Weiland ITG/TEM anomalous transport model [2] is used (in conjunction with an appropriate neoclassical transport calculation) to predict plasma profiles in ECRH heated HSX plasmas. Although the axisymmetric Weiland model cannot treat 3D geometry effects, recent 3D gyrokinetic linear stability calculations [3] have demonstrated where the local geometry is important in determining the correct linear growth rates in 3D systems. As a first approximation to incorporating 3D effects in the Weiland model, the necessary input geometry information (ε, κ, ∇B) is taken from the region in HSX where the fastest growing modes are spatially localized in the gyrokinetic calculations. This approximation provides a reasonable prediction of linear growth rates compared to those from the 3D gyrokinetic calculation.

Using model input particle and ECRH power source rates determined from 3D DEGAS and ray tracing calculations, the predicted density and temperature profiles are in reasonable quantitative agreement with a number of experimental profiles in the QHS configuration. The predicted profiles in the Mirror configuration also capture changes that are observed experimentally. While there are moderate changes in the predicted anomalous transport, the changes in the predicted profiles are largely due to the increased neoclassical transport in the non-symmetric configuration. This work is supported by DOE grant number DE-FG02-93ER54222.

[1] J.M. Canik et al., Phys. Rev. Letters **98**, 085002 (2007)
[2] H. Nordman et al., Nucl. Fusion **30**, 983 (1990)
[3] G. Rewoldt et al., Phys. Plasmas **12**, 102512 (2005)