Measured and Neoclassically Predicted Intrinsic Plasma Flows and Radial Electric Field in the HSX Stellarator

A. Briesemeister, K. Zhai, J. Lore, D.T .Anderson, F.S.B. Anderson, J.N. Talmadge

HSX Plasma Laboratory, Univ. of Wisconsin, Madison

Radial electric field and flow parallel to the magnetic field in HSX, determined from charge exchange recombination spectroscopy (CHERS) measurements, are compared to the neoclassical values calculated using the PENTA code[1]. The magnetic spectrum of HSX's optimized magnetic configuration has a single dominant helical (n=4, m=1) component, making it quasi-helically symmetric. The other spectral components all have magnitudes of less than 1% of the total field strength. Flow damping is low along HSX's helical direction of approximately constant magnetic field strength (the direction of symmetry) on a flux surface. Intrinsic rotations of up to 20 km/s along HSX's direction of symmetry have been measured, while flows across the direction of symmetry were at least an order of magnitude smaller. Poloidally symmetric (m=0) perturbations can be intentionally introduced into the magnetic field spectrum. Initial measurements have shown that the flows are relatively insensitive to this type of perturbation. The measured radial electric field and flows agree with the neoclassically predicted values in the outer half of the plasma when a momentum conserving collision operator is used in the calculations. Non-momentum conserving calculations, used to calculate flows in conventional stellarators, are shown to under-predict parallel flows by approximately an order of magnitude. In the core, where calculations predict large positive radial electric fields, disagreement is seen between the measured and predicted values. Changing the working gas from hydrogen to methane increases the measured on-axis electron temperature from 1.2 keV to 1.6 keV. The effects of impurities on neoclassically predicted flows and radial electric field will be presented.

[1] D. A. Spong, Phys. Plasmas **12**, 056114 (2005)