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Internal Electron Transport Barrier due to Neoclassical Ambipolarity in the HSX Stellarator[1]

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Strongly peaked electron temperature profiles are measured in the core of the Helically Symmetric Experiment (HSX) during electron cyclotron heating; with central temperatures of 2.5keV for 100kW of injected power. These measurements, coupled with neoclassical predictions of large "electron root" radial electric fields with strong radial shear, are evidence of a neoclassically driven thermal transport barrier. Neoclassical transport is analyzed using the PENTA code [1], in which parallel momentum is conserved. Momentum conservation, including the effects of parallel flow, has long been known to be important in tokamak neoclassical calculations. Conventional stellarators, on the other hand, typically exhibit strong flow damping in all directions on a flux surface, and the parallel flows can be neglected. In this case, the radial electric field is calculated using a simple ambipolarity constraint: setting the ion flux equal to the electron flux. In stellarators with very low effective ripple, such as HSX, parallel flow and momentum conservation are again expected to be important. Large parallel flow measurements (~20km/s) from the ChERS diagnostic are consistent with reduced damping in the direction of symmetry. In addition to neoclassical transport, a model of Trapped Electron Mode turbulence is used to calculate the turbulent-driven electron thermal diffusivity. The very peaked T_e profile is reproduced by predictive transport simulations only when turbulent transport quenching via sheared ExB flow is included [2]. ChERS measurements of the radial electric field profile and comparison to the neoclassical calculations will also be presented.

[1] D.A. Spong, Phys. Plasmas **12**, 056114 (2005).
[2] W. Guttenfelder, J. Lore, *et. al*, Phys. Rev. Lett. **101**, 215002 (2008).

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