Topic: EX-C

Transport with Reversed Shear in the National Spherical Torus Experiment (NSTX)

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Over the last several years an improved understanding of ion thermal transport in tokamaks has emerged that is based on the suppression of microturbulence by $E \times B$ sheared flows. In the area of electron transport, however, little progress has been made in the understanding of the processes causing this transport and how to reduce it. It has been predicted that reversed magnetic shear can stabilize or reduce the growth rate of micro-instabilities. To this end, we have performed a set of experiments to understand the role of magnetic shear on electron transport. We have varied the magnetic shear, keeping all other plasma conditions the same, to isolate the effect of shear on transport. The plasmas are well diagnosed with high spatial and temporal resolution measurements of the electron and ion temperature, density, and plasma toroidal rotation profiles. In addition, a new and novel motional Stark effect (MSE) diagnostic that measures the internal magnetic field pitch angle has been implemented. The MSE diagnostic utilizes a high resolution, high throughput filter to obtain good polarization from the Stark multiplet at low magnetic field (0.45 T).

A plasma startup scenario was developed that is MHD quiescent as it is important to avoid any large magnetic reconnections that have a tendency to flatten the current profile and eliminate the reversed shear profile. The plasma was limited on the inner wall to avoid a transition into H-mode. The L-mode plasma obtained was quiescent with a 1 MA flattop. The q-profile was varied by changing the current ramp rate during the startup and the timing of the start of neutral beam injection, both of which affected the current diffusion dynamics. The neutral beam power injected in these discharges was typically 2 MW. We obtained different q-profiles, as shown in the right panel in Figure 1.

The q-profiles are reconstructed using the equilibrium code, LRDFIT. The corresponding electron temperature profiles are shown in the left panel in Figure 1. In the region where the q-profiles between the two conditions is very similar (R<0.5 m, R>1.3 m), the electron temperature profiles look the same. In the core region, where the q-profiles show the largest difference, the discharge with stronger reversed shear has a much more peaked electron temperature profile. The density profiles for the two cases is generally unchanged. In addition to the higher electron temperature, the ion temperature is also higher in the case with stronger reversed shear. The corresponding electron and ion thermal diffusivities, calculated with the TRANSP code, show a drop of about a factor 5 with higher reversed shear,

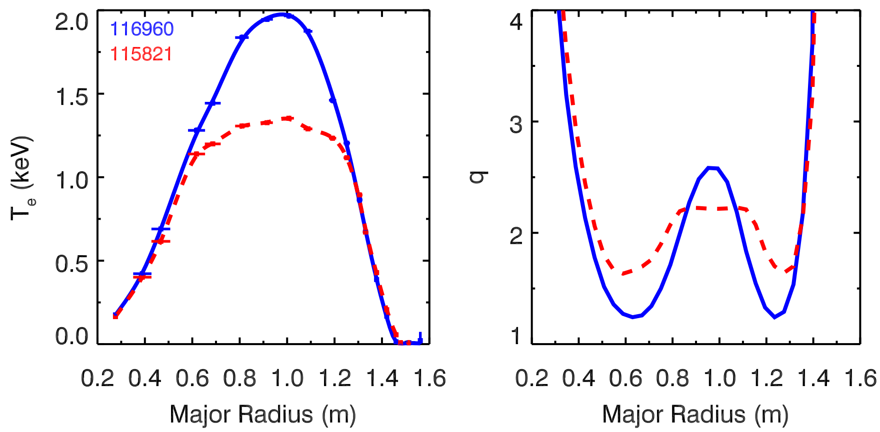

Figure 1: The electron temperature profiles (left panel) and corresponding q-profiles (right panel).

as shown in Figure 2. The neoclassical ion thermal diffusivity is shown for comparison.

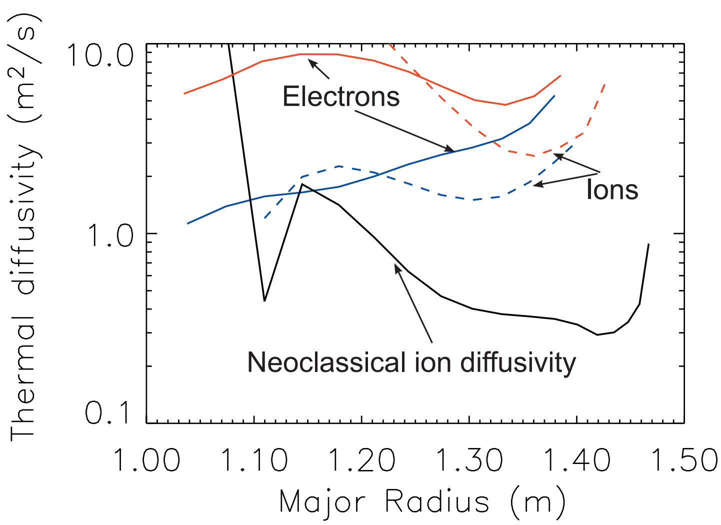

Figure 2: The blue curves with larger reversed shear have lower electron (solid line) and ion (dashed line) thermal diffusivities. The solid black line is the calculated neoclassical ion thermal diffusivity.

We are presently extending this work to include H-mode plasmas, including an "enhanced pedestal H-mode" condition which has a region of 10-15 cm about the magnetic axis with almost zero current density.

This research was supported by U.S. DOE contract DE-FG02-99ER54520.