Comparison of Plasma Flows and Currents in HSX to Neoclassical Theory

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\textbf{Overview}

- Intrinsic flows of up to 20 km/s have been observed in HSX
- These flows are in the direction of symmetry of the quasisymmetric field
- Momentum conservation is required for modeling to predict flows of this level

\textbf{PENTA Restores Momentum Conservation}

- Originally developed by Dan Simon (ORNL)
- Resulted from several years of development
- Has been expanded at HSX by dr. R. A. Briesemeister, Univ. of Wisconsin

\textbf{EX/P3-30}

• V3FIT has been used in the forward direction to interpret magnetic signals from external diagnostics.
• In the reconstruction mode, it has been used to modify profiles to improve agreement between predictions and measurements.
• With only external magnetic diagnostics, there are a broad range of profiles which can account for the signals, pointing to a need for further constrains on the reconstruction from other data.
• Improvements have and continue to be made in this regard by the V3FIT team (inclusion of Thomson scattering, ECE, MSE data).

\textbf{Summary}

- Intrinsic plasma flows and currents have been measured in HSX and compared to calculations from the PENTA and V3FIT codes.
- Large flows are observed in the direction of symmetry.
- Momentum conservation is needed to correctly model the flows (through use of PENTA).
- First 3D reconstructions of the bootstrap current have been made.
- Bootstrap current calculated with PENTA.
- Diffusion model has been applied to calculate the evolution of the bootstrap current over time.
- V3FIT in a forward mode shows good agreement between predicted signals and those measured by external magnetic diagnostics.
- The helical nature of the Pfirsch-Schluter current and the direction of the bootstrap current in a quasihelically symmetric system has been confirmed.
- The current magnitudes are reduced by the high effective transform.

PENTA and V3FIT can be applied across a broad spectrum of toroidal systems.