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EX/P3-30: Comparison of Plasma Flows and Currents in HSX to Neoclassical Theory

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The Helically Symmetric Experiment (HSX) was designed to have an axis of symmetry in the helical direction, reduced neoclassical transport and small equilibrium currents due to the high effective transform. Unlike other stellarators in which |B| varies in all directions on a flux surface, plasmas in HSX are free to rotate in the direction of quasihelical symmetry. In this paper we will present measurements with Charge Exchange Recombination Spectroscopy (CXRS) that demonstrate for the first time that intrinsic plasma flows with a velocity up to 20 km/s are predominantly in the direction of symmetry. Whereas previous neoclassical calculations did not conserve momentum, we show that the experimental results agree better with recent modifications to neoclassical theory that do conserve momentum. Also, we present for the first time a 3-D equilibrium reconstruction of the plasma pressure and current profile based on a set of magnetic flux loops. Early in time, the magnetic signals indicate that, because of the absence of toroidal curvature, a helical Pfirsch-Schlüter current develops. Later in time, the bootstrap current evolves over a time scale longer than the plasma discharge and is modeled using a 3-D suseptance matrix method. The reconstructed pressure profile agrees well with the experimental measurements. The reconstructed current profile agrees well with the neoclassical calculations of the bootstrap current including momentum conservation. However, a wide range of current profiles also show reasonable agreement with the data, indicating that the measured edge magnetic signals are not that sensitive to the small bootstrap current, especially in the plasma core and additional constraints are needed for core current profile reconstruction.

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