Measurement of the Pfirsh-Schlüter and Bootstrap Currents in HSX

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The Pfirsch-Schlüter and bootstrap currents in the quasihelically symmetric stellarator HSX are unlike that of a conventional stellarator. The lack of toroidal curvature in HSX results in a helical Pfirsch-Schlüter current that rotates as a function of toroidal angle. The Pfirsch-Schlüter current is also smaller in magnitude than for comparable magnetic fusion experiments. The bootstrap current in the HSX is in the opposite direction to that in a tokamak, reducing the rotational transform. The currents are measured with an external Rogowski coil and a newly-installed 16-element array of external B-dot pickup coils. The bootstrap current in HSX rises throughout the discharge on a 10-50 ms timescale and approaches a maximum value between 400-500A. The Pfirsch-Schlüter current rises on a 5-10 ms timescale and exhibits a dipole variation. Plasma temperature and density profiles are measured with a 10-chord Thomson scattering system, showing central electron temperatures up to 1600 eV and peak densities of 5 x 10^{12} cm^{-3}.

Several characteristics of the parallel currents have been observed. The equilibration times and maximum values can be adjusted by variation of the electron pressure profile and associated gradients. Reversal of the magnetic field reverses the direction of the parallel currents. When operating at 0.5-Tesla field strength with low plasma density, the measured net toroidal current reverses direction. At 1-Tesla field strength, the reversal of the toroidal current is not seen. HSX has the capabilities of spoiling the (n, m) = (4, 1) quasihelical symmetry by energizing a series of auxiliary planar coils. In this 'Mirror mode', an (n, m) = (4, 0) symmetry-breaking term enters the |B| spectrum and degrades the neoclassical properties of HSX and affects the resulting equilibrium currents. Theoretical models used to predict and model the Pfirsch-Schlüter and bootstrap currents will be presented.

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