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Initial Results from Biased Electrode Experiments in HSX

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HSX is the first stellarator in the world to possess a direction of symmetry in the magnitude of the magnetic field. Hence, the parallel viscosity in this direction is small compared to a conventional stellarator. This quasi-symmetry in the helical field can be broken by the addition of a toroidal mirror field. With this additional field, there are mod(B) variations in all directions on a flux surface and large parallel viscosity in all directions. Calculations show that in this "Mirror" mode, the parallel viscous damping rate is 1-2 orders of magnitude larger than in the base quasihelically symmetric configuration.

To study the physics of radial electric fields and their associated flows in HSX, we have drawn a radial current from the plasma edge with a biased electrode. The biased electrode system is capable of applying 600V of bias and drawing up to 350A of current. The bias can be applied and turned off quickly (≈10μs) and the system is capable of positive or negative bias. Plasma flows are measured using a "Gundestrup" probe and Langmuir probes are used to measure the edge T_e, n_e, V_f, and V_p profiles. We use these diagnostics to measure the flow damping rates, in both the Mirror and QHS modes of operation.

During bias, the density increases, although there seems to be no change in the edge recycling during this time. A concurrent reduction in fluctuation amplitudes indicates that confinement improvements are probably taking place during the bias. It is found that the damping rate at the edge in the QHS mode is indeed lower than the Mirror mode by a factor of ≈2.5. This difference is smaller than expected from simple parallel viscous damping. The experiment is compared to damping rate calculations using the model of Coronado and Talmadge. It is shown that by including collisions with neutrals, the experimental damping rates can be approximately reproduced.

Topic: Transport and Confinement Improvement
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