Density and Temperature Profiles With and Without Quasisymmetry in HSX

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In the Quasi-Helically Symmetric (QHS) configuration of HSX, the density profile is centrally peaked independent of the temperature profile. In a configuration with the symmetry intentionally broken (Mirror), the density profile is flat or slightly hollow with on-axis heating. When the ECH resonance is moved to the plasma mid-radius, the core temperature profile is flattened, and the density profile becomes peaked. This suggests that the hollow density profile with on-axis heating is due to a thermodiffusive particle flux. The radial particle flux has been inferred using a suite of absolutely calibrated H_α detectors coupled to 3D neutral gas modeling. It is found that in QHS, the experimental particle flux is much larger than the neoclassical value across the minor radius of the plasma. In the Mirror configuration, the core particle flux is comparable to the neoclassical expectation. In this region, the flux driven by the temperature gradient is the dominant term in the total neoclassical particle flux, suggesting that neoclassical thermodiffusion is the cause of the hollow density profile. The peaked density profiles observed in QHS plasmas indicate that, at present parameters, thermodiffusion is not a significant part of the total particle balance.

The electron temperature is significantly higher in the quasi-symmetric configuration than in a configuration without symmetry. With an injected power of 40 kW, the core temperature is ~450 eV in QHS, compared to ~250 eV when the symmetry is broken. The density and temperature profiles have been measured in fine time increments through the turn-off of the ECH power, yielding the absorbed power profile. Initial results indicate that the absorbed power is similar in the two configurations, and that the temperature difference is due to improved transport in QHS. The core thermal diffusivity in QHS is reduced an amount roughly consistent with the neoclassical difference between the configurations. This work is supported by DOE Grant DE-FG02-93ER54222.