Time Evolution of Measured Energy and Particle Transport in the MST Reversed-Field Pinch


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Abstract

Time evolution measurements of thermodynamic profiles have been obtained in a variety of MST discharges (PPCD, F=±0.02, F=±0.05, F=±0.1), leading to the first measurements of spatially resolved, time-evolving heat transport in the MST. MST discharges are absent in the PPCD plasma, and confinement is observed to improve, but depolarize rapidly as if it were always reversed. In all cases, the heat flow is predominantly conductive over the majority of the plasma volume, though convective heat transport becomes significant in the edge. The observed heat and particle fluxes cannot be accurately described by a single heat and particle flux across the edge, but is instead given by a significantly high electric field across terms. The radial electric field is calculated from ion momentum balance and compared to measurements from a heuristic one beam profile diagnostic. This work was supported by the U.S. DOE.

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Summary

- Measured electron $\gamma$ in the core of the MST is in good agreement with Resistive Reconnection type modeling (RRR/RRE) of reconnection magnetic diffusion or the ion thermal speed, suggesting that anisotropy constrains the heat flow in this case.
- The radial electric field is estimated from ion momentum balance to be $\approx 0.5$ V/m, which is in excellent agreement with measured $\gamma$, from the MST HIBP.
- PPCD plasmas are closer to Taylor minimum energy states, based on 3D profile calculations. PPCD plasmas have higher confinement than Standard, but confinement improves rapidly as $F$ is raised above 0.1.
- PPCD plasmas continue to out-perform other operational modes of the MST. $\gamma$ is more than double "Standard" plasmas, and $\gamma_\parallel$ is an order of magnitude lower.

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