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Electron thermal transport within magnetic islands in the RFP[1]

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Magnetic islands formed by tearing reconnection have a significant impact on the thermal characteristics of magnetically confined plasmas such as the reversed-field pinch (RFP). New Thomson scattering diagnostic capability on the MST RFP has enabled measurement of the thermal transport characteristics of islands. Electron temperature (Te) profiles can now be acquired at 25 kHz, sufficient to measure the effect of an island on the profile as it rapidly rotates by the measurement point. In standard plasmas with a spectrum of tearing modes, islands tend to flatten the Te profile across resonant surfaces, as observed in tokamaks. This flattening is characteristic of parallel heat conduction inside the island and is not the result of a stochastic field as it was previously thought. In striking contrast, a temperature gradient within an island is observed in improved confinement plasmas, brought about by a reduction in tearing instability. This suggests local heating and relatively good confinement within the island; local power balance calculations are underway to quantify the island thermal transport. Measurement of transport in 3D magnetic structures is key to understanding the self-organized helical equilibrium in the RFP in which one large island reorganizes the central magnetic field topology. The high rep-rate Thomson scattering diagnostic has also been used to resolve electron thermal transport during the periodic growth and decay of the tearing modes in MST. The measured electron heat conductivity is less than that predicted for transport in a fully stochastic magnetic field (Rechester-Rosenbluth). This suggests that remnant island structures are present, consistent with the direct observations described above. The stochastic field was modeled with 3D nonlinear resistive MHD simulations (DEBS code) with Lundquist numbers matching those in MST during standard discharges.

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