DPP16-2016-000387

Abstract for an Invited Paper
for the DPP16 Meeting of
the American Physical Society

Electron turbulence and transport in large magnetic islands[1]

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Magnetic islands, observed in both reversed-field pinches (RFPs) and tokamaks, often display unexpected turbulence and transport characteristics. For the first time in an RFP, the high repetition rate Thomson scattering diagnostic on MST has captured a 2D image of the rotating electron temperature structure of a magnetic island in a single discharge. MHD modeling using edge magnetic signals implies a 16 cm wide m,n=1,6 tearing mode island which completely overlaps a 5.5 cm n=7 island (12 cm between island centers). The 3D field is partially chaotic, but still reflective of the n=6 island structure. The measured temperature structure matches the shape and location of the n=6 partially chaotic (or 'remnant') island. Contrary to the usual assumption that islands have flat internal temperature, the electron temperature is peaked inside the remnant magnetic island due to ohmic heating. The temperature peaking implies a local effective perpendicular conductivity 10-40 m^2/s inside the remnant island. This agrees quantitatively with an effective perpendicular conductivity of 16 m^2/s estimated using the magnetic diffusion coefficient (evaluated at the electron mean free path) calculated from the modeled chaotic field. Statistical analysis of measurement ensembles with lower time resolution implies that remnant island heating is common in MST discharges. To investigate the role of turbulence near a magnetic island, the 2D structure of long-wavelength density turbulence has been mapped around a large applied static m,n=2,1 L-mode island in the DIII-D tokamak. The turbulence exhibits intriguing spatial structure. Fluctuations are enhanced several-fold (compared to the no-island case) on the inboard side of the X-point, but not on the outboard side of the X-point and are also reduced near the O-point.

[1]This work is supported by the NSF and US DOE under DE-FC02-04ER54698, and DE-FG02-89ER53296.