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A quantitative account of electron energy transport in an NSTX plasma*

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Anomalous electron transport in magnetized plasmas can be a major obstacle in the way toward practical nuclear fusion power, and it has been an outstanding problem for almost half a century. Here we report the first successful quantitative accounting of the electron thermal conductivity χ_e in a tokamak experiment due to imperfect magnetic surfaces[1] caused by the microtearing instabilities. The unstable spectrum is calculated with the GS2 code for a well-behaved H-mode plasma in NSTX (R/a=0.85m/0.67m) with 6 MW deuterium neutral beam heating at I_p=0.75 MA, B_t=0.5 T. The application of existing nonlinear theory[2] showed that the unstable modes can produce overlapping resistive layers and stochastic magnetic fields. The calculated χ_e based on the theory[1] is in good agreement with the values from transport analysis of the experimental data over the entire region ($0.4 < r/a < 0.75$), where the electron temperature gradient is strong enough to make microtearing the most unstable mode. There is no adjustable parameter in this comparison. In a discharge with reversed central magnetic shear and an L-mode edge, microtearing modes are found to be stable. The central electron temperature is 50% higher (2 keV vs 1.3 keV) than in the comparison shot with the microtearing instability and the same controlled tokamak parameters like plasma current, density, magnetic field, plasma shape, position and neutral beam heating power. This is a strong indication that this instability may be the dominant mechanism responsible for the electron transport in this type of plasma. Since the microtearing mode is difficult to stabilize with velocity shear, this instability is an important limit[3] on the electron temperature in spherical tokamak configurations where the usual long wavelength instabilities are not present.

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[1]A. B. Rechester, M. N. Rosenbluth, Phys. Rev. Lett. 40, 38 (1978).
[2]J. F. Drake et al., Phys. Rev. Lett. 44, 994 (1980).
[3]M. Kotschenreuther, W. Dorland et al., Nucl. Fusion 40, 677 (2000).