Scaling of Heat Transport with Collisionality

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Abstract

The scaling of heat transport with collisionality (ν) in the banana regime has been measured in both L–mode and H–mode plasmas on the DIII–D tokamak [Fusion Technol. **8**, 441 (1985)] with the other dimensionless parameters held fixed. Understanding the collisionality scaling of heat transport helps to distinguish between the different proposed mechanisms of turbulent transport and allows the origin of power degradation and density scaling of confinement to be determined. For L–mode plasmas on DIII–D, the scaling of the effective (or one-fluid) thermal diffusivity with collisionality is close to zero at all radii, $\chi_{\text{eff}} \propto \chi_B \nu^{-0.08\pm0.10}$, which is the expected scaling for the collisionless ion temperature gradient (ITG) and collisionless trapped electron modes. The ion and electron thermal diffusivities have the same collisionality scaling to within the experimental error. For H–mode plasmas, a stronger collisionality dependence of heat transport is observed, $\chi_{\text{eff}} \propto \chi_B \nu^{0.49\pm0.08}$ for a factor-of-8 scan in ν, which falls between the expected scalings of the collisionless ITG and collisionless trapped electron modes and that of the (edge) resistive ballooning mode. A portion of this H–mode collisionality scaling can be attributed to the ν dependence of neoclassical heat transport, especially in low collisionality regions of the plasma.