ABSTRACT

The ion and electron thermal diffusivities ($\chi_{i,e}$) in DIII–D discharges exhibit a strong nonlinear dependence on the measured temperature gradients. In low confinement mode (L–mode) discharges with low toroidal rotation the ion thermal diffusivity, χ_i, has an approximately Heavyside function dependence on the major radius divided by the radial scale length of the ion temperature, R/L_{Ti}. When R/L_{Ti} is less than a critical value the χ_i's are very small. When R/L_{Ti} is about equal to the critical value, χ_i increases rapidly. The electron thermal diffusivity has a somewhat similar dependence on the parameter $\theta \equiv a/L_{Te} - 2/3\ a/L_{ne} - 1.6$ where a is the plasma minor radius and L_{ne} is the density radial scale length. When θ is less than 0.0, then χ_e is small and when θ is greater than 0.0, χ_e increases linearly with θ. This type of dependence is consistent with the predictions for transport which is dominated by ion temperature gradient and electron temperature gradient modes and is a strong indicator that these modes are the main contributors toward L–mode transport in DIII–D. When strong rotational shear is present, the thermal confinement is improved in regions of the plasma. In these regions, the dependence of the diffusivities on the gradients is changed. The type of change is consistent with the physical picture that when the E×B shearing frequency is greater than the maximum linear growth rate of the modes as calculated without shear, then the modes are stabilized and the transport is reduced.