Comparison of GKS calculated critical ion temperature gradients and ITG growth rates to DIII-D measured gradients and diffusivities

D.R. Baker, G.M. Staebler, C.C. Petty, C.M. Greenfield, and T.C. Luce

General Atomics, P.O. Box 85608, San Diego, California 92186-5608

Abstract. The gyrokinetic equations predict that various drift type waves or modes can be unstable in a tokamak. For some of these modes, such as the ion temperature gradient (ITG) mode and the electron temperature gradient mode, there exists a critical gradient, above which the mode is unstable. Since the existence of unstable modes can cause increased transport, plasmas which are centrally heated tend to increase in temperature gradient until the modes become unstable. Under some conditions the increased transport can fix the gradient at the critical value. Here we present a comparison between the measured ion temperature gradients and the "critical" gradient as calculated by a gyrokinetic linear stability (GKS) code. We also present the maximum linear growth rate as calculated by this code for comparison to experimentally derived transport coefficients. Our results show that for low confinement mode (L-mode) discharges, the measured ion temperature gradient is significantly greater than the GKS calculated critical gradient over a large region of the plasma. This is the same region of the plasma where the ion thermal diffusivity is large. For high confinement mode (H-mode) discharges the ion temperature gradient is closer to the critical gradient, but often still greater than the critical gradient over some region. For the best H-mode discharges, the ion temperature is less than or equal to the critical gradient over the whole plasma. In general we find that the position in the plasma where the ion thermal diffusivity starts to increase rapidly is where the maximum linear growth rate is greater than the $E \times B$ shearing rate.

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