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Gyrokinetic Stability and Plasma Flux Surface Shape

R.E. Waltz and R.L. Miller

General Atomics
San Diego, California

This paper gives a systematic study of the effect of plasma flux surface shape on general gyrokinetic stability in the high-n ballooning mode representation. Previous studies of general geometry tokamaks and microstability have been organized about surface by surface analysis of global MHD equilibria making it difficult to isolate parametric dependences. The present study uses a generalization of the local $\hat{s}-\alpha$ equilibrium recently formulated by Miller *et al.* [1]. This formulation characterizes the local equilibrium for a shifted, elongated, and triangulated ellipse with minor horizontal radius r in terms of nine local flux surface variables: aspect ratio $A = R_0 / r$, Shafranov shift $\partial_r R_0$, elongation κ, triangularity δ, safety factor q, shear $\hat{s} = (r/q)\partial_r q$, and the MHD pressure gradient $(-\partial_r P)$ variable α, as well as two nearly degenerate variables $s_\kappa = (r/\kappa)\partial_r \kappa \approx (\kappa - \kappa_0)/\kappa$, $s_\delta = [r/(1-\delta^2)^{1/2}]\partial_r \delta \approx \delta/(1-\delta^2)^{1/2}$. The general pure plasma gyrokinetic maximum growth rates normalized to c_s / r depend on plasma β, and separate inverse temperature and density gradient length ratios $-r\partial_r \ln T_i$, $-r\partial_r \ln T_e$, $-r\partial_r \ln n_e$ in place of the pressure gradient variable. The temperature ratio T_i / T_e and collisionality also influence growth rates. The careful delineation of the local variables allows systematic study of maximum growth rate against shape variables A, κ, and δ at fixed r. Kotschenreuther's gyrokinetic code [2] modified for $B_\parallel$ perturbations and general geometry is used and recovery of the ideal MHD critical point is verified. We quantify the general stabilizing effect of low aspect ratio, high elongation and triangularity at high beta [3].

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