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Edge transport in tokamaks with noncircular flux surfaces

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Three dimensional simulations[1] of the Braginskii equations demonstrate that transport in the edge of tokamaks is controlled by two parameters: (1) the MHD ballooning parameter $\alpha_{MHD}=\beta q^2 R/L_n$, where q is the safety factor, R is the major radius, L_n is the density scale length, and β is the ratio of the plasma pressure to the magnetic field pressure, and (2) the diamagnetic parameter α_d which is proportional to the diamagnetic drift frequency. A curve in the two-dimensional parameter space α_{MHD} vs. α_d delineates regions where typical *L*-mode levels of transport arise from regions where the plasma exhibits improved *H*-mode confinement. An analytic expression for this critical curve has been obtained from a theory[2] based on zonal flow generation in a finite β plasma. The theory yields a threshold curve for zonal flow generation of the form $\alpha_{MHD}\,\alpha_d^2 \sim 0.1$. This analytic criterion can be rewritten in terms of a critical threshold parameter proportional to $T_e/L_n^{1/2}$ for the generation of zonal flow, where T_e is the electron temperature. This threshold parameter shows excellent agreement with edge measurements on discharges undergoing *L-H* transitions in the DIII-D tokamak[3]. The edge simulations in Ref. 1 were carried out for equilibria with circular flux surfaces in the large aspect ratio limit. We now investigate the effect of noncircular equilibria in a finite aspect ratio torus on edge transport in tokamaks. The noncircular equilibria are characterized by an elongation κ in the vertical direction in the poloidal cross-section along with a triangularity δ. Edge confinement is improved as the triangularity and elongation of the plasma is increased, in both the *H*-mode and *L*-mode regimes.

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