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On the Efficiency of Intrinsic Rotation Generation in Tokamaks
Y. KOSUGA, P.H. DIAMOND, O.D. GURCAN — A theory of the plasma flow generation process efficiency is presented. A measure of the *efficiency* of the plasma to produce mesoscale and mean flow from heat flux is introduced by analogy with engines, using entropy budget due to thermal relaxation and flow generation. The efficiency is defined as the ratio of entropy destruction rate due to flow generation and entropy production rate due to ∇T relaxation (i.e. related to turbulent heat flux). The efficiencies for two different cases, i.e. for the generation of turbulent driven $E \times B$ shear flow (zonal flow) and for toroidal intrinsic rotation are considered for a stationary state, achieved by balancing entropy production rate and destruction rate order by order in $O(k_\parallel/k_\perp)$ where k is a wave number of a mode. The efficiency of intrinsic toroidal rotation is derived and shown to be $e_{IR} \sim 0.01$. The scaling form of the efficiency of intrinsic rotation generation is also derived and shown to be $\rho_*^2(q^2/\hat{s}^2)(R^2/L_T^2) = \rho_*^2(L_s^2/L_T^2)$, which suggests a machine size scaling and an unfavorable plasma current scaling through the shear length.

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