Formation and Propagation of transport barriers in a coupled heat and particle flux model

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Abstract

Understanding L $\rightarrow$ H transitions is a critical problem in magnetic confinement studies. Strong nonlinearity and coupling of particle and heat fluxes result in solution multiplicity, the L-H mode coexistence. Stationary L $\rightarrow$ H transitions studied earlier revealed the pedestal width to be coupled to the fueling profile. Finite pressure curvature, however, shifts emphasis to the heating rate. To better understand the mechanism of L $\rightarrow$ H transitions, and factors controlling the pedestal width in particular, we study time evolution of the temperature and density profiles and the L-H interface propagation. The critical parameters for the transition are shown to be the ratios of turbulent and neoclassical heat and particle transport coefficients. We derive a general transition criterion for arbitrary ratios of the transport parameters. We regularly prove that the Maxwell construction rule for the transport barrier location establishes as a time asymptotic limit in the field (density or pressure) with higher transport coefficients.

The study of transport propagation shows that both the inward and outward propagation can occur. The heat production in the core region and the fueling at the edge determine the speed and direction of interface propagation. The front propagation solutions describe the penetration of the H-mode into L-mode (widening the pedestal width) and vice versa.