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TH/P3-03: Stabilizing Regimes of Edge Current Density for Pedestal Instabilities

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Resistive MHD computations using the NIMROD code find stabilizing effects of edge current density distribution on the low-n instabilities localized in the edge pedestal region. It is widely accepted that the low-n edge localized modes can be driven unstable by increasing the edge current density. The destabilization of the edge current driven peeling modes is reproduced in our computations for a tokamak equilibrium with a modest pedestal height. However, for a higher pedestal equilibrium with sufficiently large edge current density, the q profile develops a region where the magnetic shear becomes negative. In this regime, the low-n edge instabilities are partially or fully stabilized. The stabilizing effects of edge current density in regions with reversed magnetic shear appear to be consistent with a necessary condition for peeling mode stability from analytical theory. Nonlinear simulations indicate that the stabilizing effects of edge current density on the low-n edge instabilities through reverse shear can persist throughout the nonlinear exponential growth phase. These stabilizing effects delay the subsequent nonlinear stage, during which the filament size in the radial direction exceeds the pedestal width and disconnected blob-like substructures start to develop within the filaments. The energy loss from these radially extending filaments can reach above 10% of the total energy in pedestal. We present a systematic study on the stabilizing regimes of edge current density, and use nonlinear simulations to explore how these regimes can be exploited for the control of edge localized instabilities in experiments.

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