Linear and Nonlinear Plasma Responses to RMPs in Tokamak Edge Pedestal Region *

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Abstract

Resonant magnetic perturbations (RMPs) are believed to play important roles in suppressing and mitigating the edge localized modes (ELMs) in tokamak experiments. To understand the effects of RMPs on the properties of tokamak edge pedestal plasma, linear plasma response has often been assumed in calculations and interpretations. In this work, we compare linear and nonlinear calculations on the plasma responses of the edge pedestal region to RMPs in a circular-shaped limiter tokamak, using both a reduced MHD model in theory and a full MHD model with anisotropic heat transport implemented in the NIMROD code. A low-n RMP with a single helicity is imposed as the boundary condition at the tokamak wall location, where n is the toroidal mode number. Plasma responses to RMPs are obtained through solving and analyzing the steady states of the linear and the nonlinear MHD system subject to the RMP boundary condition. For a given RMP, it is found that there can be substantial difference in magnitude between the linear and nonlinear plasma response in the highly resistive regime. Such a difference tends to diminish as the resisitivy reduces toward the ideal regime. Linear and nonlinear plasma responses can be also quite different on the resonant flux surfaces located near the pedestal foot. As the resonant surface moves inward the pedestal, the difference can become insignificant. The underlying physics for the dependence of the difference in linear and nonlinear plasma responses on the resistivity and the resonant location will be discussed.

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