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TH/P4-21: Edge Plasma Response to Non-Axisymmetric Fields in Tokamaks

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The application of non-axisymmetric fields is found to have significant effects on the transport and stability of H-mode tokamak plasmas. These effects include dramatic changes in rotation and particle transport, and may lead to the partial or complete suppression of edge-localized modes (ELMs) under some circumstances [1]. The physical mechanism underlying these effects is presently not well understood, in large part because the response of the plasma to non-axisymmetric fields is significant and complex. Here, recent advances in modeling the plasma response to non-axisymmetric fields are discussed. Calculations using a resistive two-fluid model in diverted toroidal geometry confirm the special role of the perpendicular electron velocity in suppressing the formation of islands in the plasma [2]. The possibility that islands form near the top of the pedestal, where the zero-crossing of the perpendicular electron velocity may coincide with a mode-rational surface, is explored, and the implications for ELM suppression are discussed. Modeling results are compared with empirical data. It is shown that numerical modeling is successful in reproducing some experimentally observed effects of applied non-axisymmetric fields on the edge temperature and density profiles. The numerical model self-consistently includes the plasma, separatrix, and scrape-off layer. Rotation and diamagnetic effects are also included self-consistently. Solutions are calculated using the M3D-C1 extended-MHD code [3].

[1] T.E. Evans, et al., Phys. Rev. Lett. 92, 235003 (2004).
[2] N.M. Ferraro, et al., "Calculations of two-fluid linear response to non-axisymmetric fields in tokamaks," submitted to Phys. Plasmas (2011).
[3] N.M. Ferraro, S.C. Jardin, and P.B. Snyder, Phys. Plasmas 17 102508 (2010).

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