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Impact of edge magnetic perturbation (MP) on multi-scale turbulence and turbulent transport across a MP-induced edge transport reduction in the TEXTOR tokamak

Y. He[1], Y. Xu[1], I. Shesterikov[2], M. Vergote[2], M. Van Schoor[2], A. Krämer-Flecken[3] and J. Cheng[1]

[1] Institute of Fusion Science, School of Physical Science and Technology, Southwest Jiaotong University, Chengdu 610031, Sichuan, People's Republic of China

[2] Laboratoire de Physique des Plasmas-Laboratorium voor Plasmafysica, Ecole Royale Militaire-Koninklijke Militaire School, Trilateral Euregio Cluster, B-1000 Brussels, Belgium

[3] Institute of Energy and Climate Research-Plasma Physics, Forschungszentrum Jülich GmbH, Association EURATOM-FZJ, Trilateral Euregio Cluster, D-52425 Jülich, Germany

e-mail: heyu1993@my.swjtu.edu.cn

Abstract

In recent years, the externally applied resonant magnetic perturbation (RMP) has been widely used in magnetic fusion devices for mitigation or suppression of the edge localized mode [1] and control of MHD activities [2]. As the RMP modifies magnetic topology at the plasma boundary, the edge radial electric field, plasma rotations, turbulence and turbulent transport as well as zonal flows can also be significantly affected in the stochastic field line region. In most H-mode experiments, the effects of RMP are commonly corroborated to be associated with the changes in edge magnetic topology and potential responses of instabilities in a specific phase-space operating window of the 3D field. In contrast, in Ohmic experiments, the influence of RMP on plasma properties reflects more on the change in fundamental features of edge turbulence and associated transport in the stochastic region.

In the Ohmic discharge at the TEXTOR tokamak, reduced particle losses have been observed during the operation of an m/n=6/2 resonant magnetic perturbation. We therefore investigate the impact of the perturbation field on multi-scale turbulence and turbulent transport across the perturbation-induced reduction of edge transport [3]. The results indicate that with magnetic perturbation (MP), both the large-scale zonal flows and small-scale drift-wave turbulence are significantly reduced. At high MP currents, a reduction of edge transport can be realized due to primarily the decline of small scale ambient turbulence and turbulent transport in the ergodic zone, where the turbulence eddy size is largely decreased. Investigation on the dynamic process of fluctuation quantities during the perturbation current ramp-up phase further shows that geodesic acoustic mode zonal flows and their nonlinear interaction with background turbulence decrease incessantly with increasing perturbation current. The transport reduction takes place only after small-scale turbulence starts to be strongly reduced by the MP when the MP strength reaches a certain threshold value.

References

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