Modeling of plasma beta effects on the magnetic island structure and edge plasma transports in W7-X

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To support high-performance long-pulse plasma operations for W7-X, plasma beta effects on the magnetic island structure and edge plasma transports has been systematically studied by using the 3D equilibrium code HINT [1] and the 3D transport code EMC3-EIRENE [2, 3]. Finite-beta full-field equilibria for the four most important configurations of W7-X (standard, high-mirror, high-iota and low-iota configurations) are obtained from HINT calculations. Poincaré plots of these finite-beta equilibrium shows significant changes in the magnetic island structure and the main plasma volume [4]. Such magnetic topology changes induced by finite beta effects are significantly reflected in plasma transport behaviors and the heat flux pattern on divertor targets [5]. The EMC3-EIRENE simulations for high performance plasmas in the standard configuration indicate that the threshold separatrix density for accessing the power detachment is reduced in higher beta plasmas. Compared with the vacuum field case, the impurity radiation distributions with finite beta effects are changed in the magnetic island region. For the divertor flux, the different pressure profiles with the same central beta result in modified heat flux pattern on the divertor targets. The strike line on horizontal divertor targets moves to the pumping gap with an increase in the plasma beta, and moves away from the pumping gap with the toroidal plasma current.

References

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[4] S. Zhou *et al.*, Equilibrium effects on the structure of island divertor and its impact on the divertor heat flux distribution in Wendelstein 7-X, in preparation.

[5] S. Xu *et al.*, EMC3-EIRENE modeling with finite beta effects in the standard configuration on W7-X with the island divertor, in preparation.