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Theoretical understanding of error field penetration in EAST

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One of the great challenges for the steady state operation in tokamak plasma is the error field problem. Error field can induce locked mode and result in major disruption has been recognized since 30 years ago. According to the theory extrapolation, the tolerance of error field is smaller for a larger device. Therefore, error field has long been a concern in many famous tokamaks. However, theoretical analysis seldom gives satisfied answers for the error field scaling experiments.

To better understand the error field problem, series of error field penetration experiments using n=1 and n=2 RMP have been carried out in EAST. To understand the spectrum effects, the MARS-F code is employed. Plasma response modeling by using MARS-F code well reproduces the dependence of error field penetration threshold on RMP spectrum. As one of the essential issues in error field study, density scaling on field penetration is also a significant concern. A similar density scaling has been observed using different n=1 RMP spectrum. One of the most uncertainties in determine the density scaling is the density dependence of momentum dissipation time, which significantly influence the final scaling. The density dependence of momentum dissipation time is estimated from energy confinement time measured in the experiment. It is almost independent of plasma density. This means that the usually used assumption of Neo-Alcator linear scaling is not applicable here. The obtained theoretical scaling on the basis of experiment momentum dissipation time successfully explained the observed experimental scaling. In addition, some other new observations on n=2 error field penetration in EAST, e.g. field penetration scaling, excitation of n=2 TAE mode by barely trapped energetic electrons accelerated by force reconnected island etc., will also be presented.

References

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