Fast-ion losses induced by the far non-resonant components of RMP field and the related optimization

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The impact of resonant magnetic perturbation (RMP) on the loss of energetic passing ions is investigated through numerical simulations. It is found that the poloidal components of the RMP field, with poloidal mode numbers significantly higher than those of particle orbits, exert a non-negligible influence on the drift islands of energetic particles (EP), as shown in Fig.1.

A neater magnetic topology does not necessarily lead to a better EP confinement. This has been interpreted in a previous work, which revealed that the sideband contribution from non-resonant components as a whole can be more considerable than the primary contribution from resonant component[1]. To gain a further understanding for the significant sideband resonance, the perturbation of each poloidal component is calculated from the perspective of EP. The results indicate that the drift motions of particles make the resonant field amplification effect of the plasma response more critical than the stochastization of magnetic topology in EP losses induced by the RMP field. On the other hand, the predicted role of magnetic islands in inhibiting the occurrence of edge-localized modes (ELMs) has been confirmed experimentally[2]. The different dominant components between EP losses and ELM suppression indicate that the same potential for ELM control can be achieved with different degrees of fast-ion confinement deterioration. By optimizing the phase difference between the upper and lower RMP coils in our simulations, the relative reduction in fast-ion losses can reach approximately 50%. Therefore, understanding the underlying mechanisms of EP losses induced by RMP is important for the further exploration of optimizing the ELM suppression.

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References

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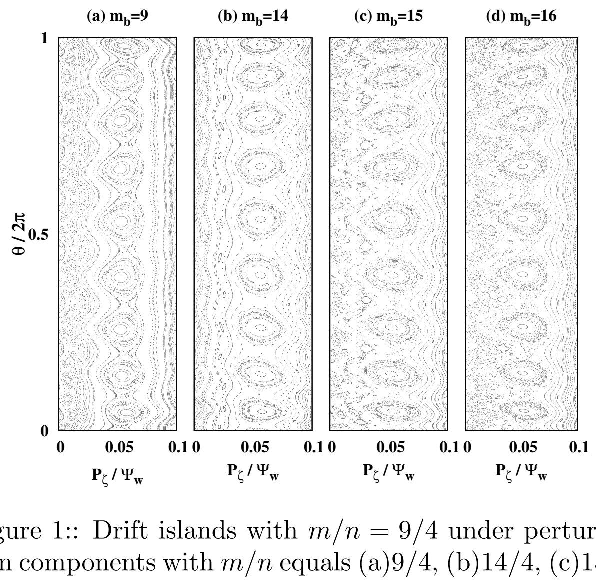

Figure 1:: Drift islands with $m/n = 9/4$ under perturbation components with m/n equals (a)9/4, (b)14/4, (c)15/4 and (d)16/4.