Effect of Ripple-Induced Transport on H-mode Performance in Tokamaks

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A number of experiments have shown [1,2] that ripple-induced transport influences performance of ELMy H-modes in the tokamak. A noticeable difference in confinement, ELM frequency and amplitude was found between JET (with ripple amplitude δ~0.1%) and JT-60U (with δ~1%) in otherwise identical discharges [1]. It was previously shown in JET experiments with enhanced ripple [2] that a gradual increase in the ripple amplitude first leads to a modest improvement in plasma confinement, which is followed by the degradation of edge pedestal and further transition to the L-mode regime if δ increases further. The DIII-D [3] team recently reported a marginal increase in confinement in experiments with an edge transport enhanced by the externally driven resonant magnetic perturbation. Numerical predictive modelling of the dynamics of ELMy H-mode JET plasma relevant to a JET/JT-60U similarity experiment [1] has been conducted taking into account ripple-induced ion transport, which was computed using the orbit following code ASCOT [4]. This predictive modelling reveals that, depending on plasma parameters, ripple amplitude and localisation (the latter depending on the toroidal coil design), this additional transport can either improve global plasma confinement or reduce it. These controlled ripple losses might be used as an effective tool for ELM mitigation and may provide an explanation for the difference between JET and JT-60U observed in the similarity experiments. A detailed comparison between ripple-induced transport and the alternative method of ELM mitigation by an externally driven edge magnetic perturbation is discussed. The fact that ripple losses mainly increase ion transport, while a stochastic magnetic layer increases electron transport indicates that it might be beneficial to use a combination of both methods in future experiments.

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