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# Impact of externally applied 3D fields on plasma rotation and correlation to fast-ion losses

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Externally applied magnetic perturbations (MPs) are amongst the most effective tools to mitigate and suppress edge localized modes [1]. Recent experiments have highlighted that the plasma response to the externally applied 3D fields plays a key role in the ELM suppression mechanism [2,3]. In this work, we study how changes in the plasma density and rotation correlate with the orbit topology of the lost fast-ions due to MPs. The study is based on a new analysis technique, which allows us to characterize the coupled temporal evolution of plasma density, toroidal rotation and fast-ion losses. The technique relies on the calculation of the correlation (based on the linear Pearson coefficient) between the signals. The correlation ranges between [-1,1], such that -1, 1 and 0 indicate inverse, coupled and decoupled temporal evolution, respectively. A detailed correlation study was performed for two low collisionality H-mode discharges at the ASDEX Upgrade tokamak. In these experiments, the application of static n=2 MPs produce impurity toroidal rotation braking, electron density pump-out and enhanced fast-ion losses. The first correlation patterns resolved in energy and pitch angle (owing to the resolution of the fast-ion loss detectors) and radius (given that density and rotation measurements are well localized) are presented. The correlation becomes more intense towards the plasma edge, in agreement with the observation that the lost fast-ions are born at the edge and can have a stronger impact on rotation there. There is also an abrupt change of sign in the correlation due to a variation in pitch angl, which coincides with the trapped/passing boundary. This observation suggests the effect of the accumulation of resonances in the trapped/passing boundary, which can affect the confinement of fast-ions. This result is in line with previous observations of the existence of an edge resonant transport layer [4]. Possible mechanisms responsible for the experimental observations are discussed. The ASCOT [5] code will be used to analyze the changes in the fast-ion torque profile due to MPs. An estimation of the radial current induced by fast-ion losses and its impact on Er is assessed.
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