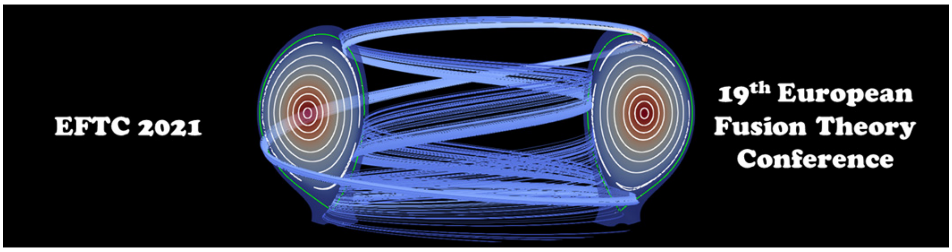

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Fast ion-induced transport barriers in global gyrokinetic simulations

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The performance of magnetic confinement devices is determined mainly by turbulent transport inducing particle and energy losses, and limiting plasma confinement. Among the different experimental actuators of turbulence, supra-thermal particles –generated via external heating –are typically considered one of the most efficient in suppressing ion-temperature-gradient (ITG) driven turbulence. In this context, valuable steps into understanding the underlying physical mechanisms responsible for this turbulence regulation have been taken from first principle gyrokinetic simulations. In particular, recent results have shown that fast particles can resonate with the bulk ion-driven ITG micro-instabilities when their magnetic drift frequency is close to the ITG frequencies. When this resonant condition is fulfilled, supra-thermal particles can deplete the free energy content of the ITG instabilities if the fast particle temperature gradient exceeds the respective density gradient. Signatures of this potentially beneficial resonant interaction have been observed at ASDEX Upgrade, JET and are also expected for W7-X and the ramp-up phase of an ITER standard scenario. In this contribution, we present results of radially global GENE simulations showing that this wave-particle resonant mechanism might trigger the formation of a new type of transport barrier, called F-ATB (fast ion-induced anomalous transport barrier). These numerical findings guided the design of a recent ASDEX Upgrade experiment, maximizing the beneficial role of the wave-particle resonance interaction. Features of transport reduction and the formation of a central region of improved confinement were observed together with no degradation of the energy confinement during the external heating power ramp-up.

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