INTERPLAY BETWEEN ENERGETIC PARTICLE DRIVEN GAMs AND TURBULENCE

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Understanding turbulent transport in magnetic fusion devices is crucial on the route towards the steady-state production of energy. An ubiquitous element in these devices is the presence of energetic particles (EP) due to both nuclear reactions and external heating like Ion Cyclotron Resonance Heating (ICRH) and Neutral Beam Injection (NBI). When turbulence and EP coexist, their interaction cannot be neglected. While the impact of turbulence on EP has been extensively analysed and found to be weak [1], the effect of EP on turbulence has been little explored and constitutes the aim of this study, where we report on the first evidence of turbulence modified by EP in gyrokinetic simulations. This interplay occurs *via* the excitation of a class of EP driven modes: the energetic geodesic acoustic modes (EGAMs). These modes were observed in ICRH discharges in the JET tokamak [2], in counter-beam NBI discharges in DIII-D [3], predicted theoretically in hybrid models [4] and analysed numerically in full-*f* gyrokinetic simulations [5]. The motivation of the present study relies upon the fact that GAMs have been found to control the turbulence level in fluid simulations [6] and to play a role in the L-H transition in the ASDEX Upgrade tokamak [7]. Therefore, controlling the excitation of GAMs by external heating could allow one to control the turbulence.

In this context, the full-*f* 5D gyrokinetic GYSELA code [8] is used to prove the impact of EP on electrostatic turbulence. For this purpose, EGAMs are excited for the first time in flux-driven turbulent simulations in the presence of a transport barrier. This is done by means of a heating source specifically implemented to increase the population of EP in GYSELA simulations. It turns out that the excited EGAMs do not suppress turbulence. On the contrary, it is shown that the interaction is such that turbulent transport is enhanced in the presence of EGAMs with the subsequent destruction of the transport barrier. This means that a control of turbulence with externally driven oscillating sheared flows is not as straightforward as could be expected. However, we show that, even if the turbulent transport is not reduced, it is modulated at the EGAM frequency [9].

The previous analysis is based on the electrostatic approximation, where the main component of the perturbations is m=1 [5]. However, a global structure of the mode was obtained in experiments, with a dominant m=2 magnetic component extending to the plasma edge, where it is detected by Mirnov coils [2]. Whether the interaction between turbulence and EP *via* EGAMs is modified or not when the magnetic components are included remains an open question. To elucidate the effect of the magnetic components of EGAMs, the full-*f* 5D electromagnetic and gyrokinetic NEMORB code [10] is used. We report here on the excitation of EGAMs in electromagnetic simulations in the linear and nonlinear phases, which are compared to the results of electrostatic GYSELA simulations.

References

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