Interaction of fast particles and Alfvén modes in burning plasmas

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In this paper we will study the interaction of fast particles with Alfvénic instabilities in burning plasmas, with reference to present-day experiments that exploit strong energetic particle heating (namely, JT-60U [1]) and to the consistency of proposed ITER burning plasma scenarios [2]. With reference to JT-60U, two different types of bursting modes have been observed by MHD spectrography in auxiliary heated (NNB) discharges. One of these modes has been dubbed fast frequency sweeping (fast FS) mode. It is characterized by a timescale of the order of few milliseconds and frequencies branching upwards and downwards. The other mode, called the abrupt large-amplitude event (ALE), has shorter timescale (order of hundred microseconds) and larger amplitude. On the occurrence of ALEs, a significant reduction of the neutron emission rate in the central plasma region is observed. Such a change can be attributed to a redistribution of the energetic ions, with a marked reduction of their on-axis density. We will present an interpretation of these experimental observations based on the results of nonlinear particle simulations performed by the Hybrid MHD-Gyrokinetic Code HMGC [3].

With reference to ITER, if the energetic particle pressure is above the threshold for resonant excitation of Energetic Particle driven Modes (EPMs), significant modification of the energetic particle pressure profile can take place. The model simulations we present retain all the relevant thermal-plasma parameters, the safety factor and alpha-particle pressure profiles. ITER monotonic-q (scenario 2) and reversed-shear (scenario 4) equilibria have been considered. Also an ITER hybrid scenario will be studied and quantitatively compared with the previous ones. The transition from the low-amplitude Alfvénic instability saturation to the secondary excitation of a stronger mode will be addressed, and its effect on the energetic particle transport will be analyzed.

References

[1] Shinohara K. et al. 2004 *Plasma Phys. Contr. Fusion* **46** S31–45

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