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Particle simulation of bursting Alfvén modes in JT-60U

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Periodic radial redistributions of energetic ions in NNB heated discharges in JT-60U appear to be caused by Abrupt Large-amplitude Events (ALEs): bursting modes, with hundred-microsecond time scales. Between two successive ALEs, weaker fast Frequency Sweeping (FS) modes occur, with millisecond time scales. Particle simulations of a typical NNB-heated JT-60U discharge is presented. Assuming the energetic-ion density profile experimentally observed immediately before an ALE and postulating an anisotropic slowing-down distribution function, we find that a fast-growing mode is destabilized at half radius. Its saturation is accompanied by a macroscopic outward displacement of energetic ions. Frequency range, time scale and broad resonance region support the identification of such a mode with an ALE. The main features of the quiescent phase observed between two ALEs (namely, the destabilization of low-growth-rate, low-amplitude fast FS modes) are then recovered if we initialize energetic ions according to the distribution function modified by the former bursting mode, caring to include both the density profile relaxation and the distortion of the velocity space distribution function. The experiments could then be interpreted as follows: given the energetic-ion source provided by beam injection, the free energy reconstruction rate is set by the rebuilding of the velocity space distribution function. The intermediate fast ion phase-space profiles between two ALEs are characterized by lower mode drive than that of a slowing-down distribution with the same energetic-ion density profile. Weak fast FS modes are then excited, which are unable to contrast the density profile reconstruction. As soon as the combined restoration of the configuration and velocity space distribution provides enough drive for a fast growing Alfvén mode, a new ALE occurs.