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**Self-consistent long-time simulation of chirping energetic particle modes and abrupt large events in beam-driven JT-60U tokamak plasmas**[1]

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— Recurring bursts of chirping Alfvén modes as well as so-called Abrupt Large Events (ALE) that were observed in JT-60U tokamak plasmas driven by negative-ion-based neutral beams (N-NB) are reproduced in first-principle simulations performed with an extended version of the hybrid code MEGA. This code simulates the interactions between gyrokinetic fast ions and magnetohydrodynamic (MHD) modes in the presence of a realistic fast ion source and collisions, so that it self-consistently captures dynamics across a wide range of time scales (0.01–100 ms). Detailed comparisons with experimental measurements are performed. On the long time scale (10–100 ms) the simulation reproduces ALEs with the associated avalanche-like transport of fast ions. ALEs are shown to occur when multiple modes with toroidal mode numbers $n = 1, 2, 3$ are excited to large amplitudes. On the meso time scale (1–10 ms), bursts of chirping modes are reproduced, which are shown to be $n = 1$ energetic particle modes (EPM). On the short time scale (0.01–0.1 ms), pulsations and phase jumps are reproduced, which we interpret as the result of beating between multiple resonant wave packets.

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