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A Reduced Model of ELM Mitigation by SMBI and Pellet Injection

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The importance and urgency of ELM control for ITER urge to develop tractable reduced model to understand ELM mitigation experiments because first principle models of ELMs have not been developed due to terrific complexities of ELM-related physics. In this work, we present such an effort particularly focused on ELM mitigation experiment by supersonic molecular beam injection (SMBI) and pellet injection (PI). We employ cellular automata model (CA) including key physical elements for transport (i.e. turbulent transport, its suppression by diamagnetic shear flow, and MHD limit) in the H-mode pedestal and expand it to include the SMBI and PI. A finding is that extended CA model can capture many essential features of the experiments, and both SMBI and pellet injection can be seen as different regions of a continuous spectrum of experiments with varying amounts and penetration depths of injected material. Shallow and small injection (SMBI) can mitigate large ELMs by triggering more frequent, yet smaller scale ejection events. With larger and deeper deposition of material, injection forces the formation of pedestal pressure profiles which trigger large ELMs. Therefore, repetitive deep injection emerges as ELM pacing.

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