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ELM mitigation by supersonic molecular beam injection into the H-mode pedestal in the HL-2A tokamak

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Abstract
Density profiles in the pedestal region (H-mode) are measured in HL-2A and the characteristics of the density pedestal are described. Cold particle deposition by supersonic molecular beam injection (SMBI) within the pedestal is verified. Edge-localized mode (ELM) mitigation by SMBI into the H-mode pedestal is demonstrated and the relevant physics is elucidated. The sensitivity of the effect to SMBI pressure and duration is studied. Following SMBI, the ELM frequency increases and the ELM amplitude decreases for a finite duration. Increases in ELM frequency of $f_{\mathrm{ELM}}^{\mathrm{SMBI}}/f_{\mathrm{ELM}}^{0} \sim 2$–$3.5$ are achieved. This experiment argues that the ELM mitigation results from an increase in higher frequency fluctuations and transport events in the pedestal, which are caused by SMBI. These inhibit the occurrence of large transport events which span the entire pedestal width. The observed change in the density pedestal profiles and edge particle flux spectrum with and without SMBI supports this interpretation. An analysis of the experiment and a model shows that ELMs can be mitigated by SMBI with shallow particle penetration into the pedestal.

(Some figures may appear in colour only in the online journal)