

Dynamics of a local defect in one-dimensional driven flow: Interplay of jamming, condensation, and tracer diffusion

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We investigate the dynamics of a localized defect, known as the slow-bond (SB), in one-dimensional driven flows to uncover how particle interactions and defect-induced jamming shape the Kardar-Parisi-Zhang (KPZ) universality class. First, we introduce zero-range process (ZRP) hopping rates into the totally asymmetric simple exclusion process (TASEP) to explore the competition between SB-induced jamming and interaction-driven condensation. We construct a comprehensive phase diagram demonstrating that specific particle interactions actively suppress the jamming effect, thereby localizing the defect's impact in the thermodynamic limit. Furthermore, we deploy positive and negative passive tracer dynamics to probe the asymptotic KPZ properties of this modified system. By tracking the anomalous diffusion and displacement distributions of these tracers, we systematically reveal how the localized defect deforms KPZ universal dynamics.

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