Scaling in the exclusion process with long-range hopping

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We investigate the exclusion process in which particles may jump any distance $l \geq 1$ with the probability that decays as $l^{-(1+\sigma)}$. Besides the localization of the domain-wall at first-order phase transition, previous results [1] have shown a change in the continuous phase transition to the maximum-current phase. In particular, the exponent of the algebraic decay of the density profile differs from the short-range value 1/2 in the region $1 < \sigma < 2$, where its dependence on σ was given by the conjecture based on numerical simulations. In the present work, we obtain the exact value of this exponent from a hydrodynamic equation for the density profile in the mean-field approximation [2]. For $\sigma > 2$, this equation is given by the viscous Burgers equation of the short-range case, but the usual diffusion term of this equation is replaced by the fractional one for $1 < \sigma < 2$. The nonlocal character of this term induces the external field that creates and annihilates particles in the bulk, similar to the exclusion process with Langmuir kinetics [3], but with site-dependent rates that influence the scaling behavior in the maximum-current phase. In case of the translationally invariant system, the equation can be mapped onto the fractional Kardar-Parisi-Zhang equation [4] which predicts the value of the dynamical exponent $z = min\{\sigma, 3/2\}$, in agreement with the results of our numerical simulations on the half-filled chain with periodic boundary conditions.

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