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KPZ- and Related Behavior of Hydrodynamics in One Dimension

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Abstract:

The dynamics of generic one-dimensional hamiltonian systems with translation invariant short-ranged interaction potentials are shown to be determined by the Kardar-Parisi-Zhang universality class. Scaling functions obtained by Prähofer and Spohn by solving the polynuclear growth model[1] can be used to obtain exact expressions for the long time behavior of sound mode time correlation functions. From this, in turn heat mode time correlation functions can be shown to decay exponentially with decay rates proportional to $k^{5/3}$, with k the wave number of the mode
The Green-Kubo integrands for the corresponding current-current time correlation functions decay with time as $t^{3/5}$ respectively $t^{2/3}$. For a finite system of length L the sound mode damping constant diverges with system size as $L^{1/2}$ and the heat conduction coefficient as $L^{1/3}$. Coefficients can be obtained from the Prähofer-Spohn scaling functions combined with mode-coupling amplitudes as obtained by Ernst, Hauge and Van Leeuwen[2]. Due to the presence of three conserved densities (mass, momentum and energy), giving rise to three hydrodynamic modes with different propagation velocities (+ or $-c_0$, the adiabatic sound velocity for the sound modes, and zero for the heat mode), there are important and still superdiffusive corrections to the asymptotic long time respectively large size behaviors. By using mode coupling techniques one can estimate these corrections as well. Simulations by Posch[3] on a square-shoulder model confirm most of these predictions, including the slowness of convergence to the asymptotic results.

[1] M. Prähofer and H. Spohn, Exact scaling functions for one-dimensional stationary KPZ growth, J. Stat. Phys. **115** (2004) 255.
[2] M. H. Ernst, E. H. Hauge and J. M. J. van Leeuwen, Asymptotic time behavior of correlation functions. II, Kinetic and potential terms, J. Stat. Phys. **15** (1976) 7.
[3] H. Posch, private communications.