Exact results for transport properties of one-dimensional hamiltonian systems

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The dynamics of generic one-dimensional hamiltonian systems with translation invariant short-ranged interaction potentials are shown to be in 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 the Green-Kubo integrands for heat diffusion and sound attenuation, as well as for system size dependent coefficients of heat conduction and sound damping. The Green-Kubo integrands decay with time as $t^{-2/3}$; the sound mode damping constant diverges with system size as $L^{1/2}$ and the heat conduction coefficient as $L^{1/3}$. The coefficients can be obtained exactly 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.

Previous results by Delfini et al. [3] provide a correct one-loop mode coupling approximation to these exact results for weakly anharmonic chains. However, these results require corrections as soon as c_p / c_v deviates appreciably from unity.

Exceptions to these results occur in case some of the mode coupling amplitudes are vanishing. The condition for this is $\left(\frac{\partial c0n}{\partial n}\right)_s = 0$. This is satisfied for a number of exactly solvable models such as harmonic chains, but it may also happen in special points, lines etc. in the phase diagrams of not exactly solvable models.

[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] L. Delfini, S. Lepri, R. Livi and A. Politi, *Self-consistent mode-coupling approach to one-dimensional heat transport*, Phys. Rev. E**73** (2006) 060201;
L. Delfini, S. Lepri, R. Livi and A. Politi, *Anomalous kinetics and transport from 1D self-consistent mode-coupling theory*, J. Stat. Mech. (2007) P02007