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Hydrodynamics of integrable systems, and an application to non-equilibrium fluctuations in transport

Hydrodynamics is a powerful framework for describing the large-scale behaviours of many-body systems in inhomogeneous, non-stationary states. Until recently, however, it was restricted to non-integrable models, as the assumption of local thermodynamic equilibrium is broken by the large amount of conserved charges afforded by integrability. I will describe how to generalise hydrodynamics to integrable systems. The resulting theory has a rich structure, and applies to large families of quantum and classical field theories, chains and gases. It allows us to solve experimentally relevant setups such as the famous ``quantum Newton's cradle" in cold atomic gases, and to evaluate exact non-equilibrium currents, correlations, Drude weights and full counting statistics of fluctuations in non-equilibrium transport. If time permits, I will explain the latter, which is based on new very general developments showing how linear fluctuating hydrodynamics gives access to the exact large deviation theory of ballistic transport.