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Empirical manifestations of integrability in cold quantum gases[1]

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Integrable quantum many-body systems traditionally belong to the domain of mathematical physics, with little or no connection to experiments. However, the experiments on confined quantum-degenerate gases has recently yielded faithful realizations of a number of integrable systems, thus making them phenomenologicalily relevant.
We show that the presence of few-body conserved quantities in a quantum system leads to dramatic, initial-state-dependent discrepancy between the state of the system after relaxation and the predictions of thermodynamics. Using the newly introduced concept of constrained thermal equilibrium we study quantitatively the effects of the memory of the initial conditions. As objects of study we choose bosons in one-dimensional optical lattices in the deep Mott regime and spin-0 Bose gases confined to waveguides, both of which have been experimentally realized already. We suggest momentum distribution and chemical composition as the simplest experimental observables sensitive to the effects of integrability.
Overall, we argue that the kinetic and thermodynamic properties of integrable quantum gases are so different from the usual, that they well-qualify for a new state of quantum matter .

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