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Can quantum many-body systems behave as strongly chaotic, being completely integrable ?

We study the paradigmatic Lieb-Liniger (LL) model belonging to the class of integrable quantum many-body systems, by considering its statistical properties in the many-body Hilbert space. We demonstrate that, for a fixed total momentum, the properties of both energy spectra fluctuations and many-body eigenstates follow the predictions of the random matrix theory. Specifically, for a finite number of bosons in a finite number of momentum levels and sufficiently strong interaction, the level spacing distribution manifests the crossover from the Poisson to the Wigner-Dyson statistics. In the latter situation, the many-body eigenstates can be treated as fully random, in spite of a deterministic nature of matrix elements. By studying the quench dynamics of an initially excited state of the unperturbed Hamiltonian, we have discovered a remarkable relation between the thermodynamic entropy emerging after the relaxation of the system to equilibrium, and the diagonal entropy related to the initial state. Our semi-analytical predictions of the onset of thermalization in the LL model are fully confirmed by numerical data.