Emergent dynamics in a one-dimensional Bose gas

Sunday, 10 September 2023 22:40 (20 minutes)

The relationship between many-body interactions and dimensionality is key to emergent quantum phenomena. A striking example is the Bose gas, which upon confinement to one dimension (1D) obeys an infinite set of conservation laws, prohibiting thermalization and steering dynamics. We experimentally demonstrate that the integrable dynamics of a Bose gas can persist deep within the dimensional crossover regime. Starting from a weakly interacting, one-dimensional Bose gas, we perform a quench to instigate dynamics of a single density mode. We find that its relaxation accurately follows predictions of dephasing from the integrable theory, even for temperatures up to three times the conventional limit for one-dimensionality. We attribute our observations to an emergent Pauli blocking of the 3D excitations, caused by the relevant collective excitations of the system assuming fermionic statistics, despite the gas being comprised of weakly interacting bosons. Our experiment demonstrates how the integrable solutions can be employed to establish a direct link between microscopic details of the system and its observed macroscopic behaviour, thus presenting new avenues to investigate emergent quantum many-body phenomena.

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Session Classification: Poster Session I

Track Classification: Quantum Gases in Low Dimensions