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Many-body localization: Local integrals of motion, area-law entanglement, and quantum dynamics DMITRY ABANIN, Perimeter Institute for Theoretical Physics, MAKSYM SERBYN, Massachusetts Institute of Technology, ZLATKO PAPIC, Perimeter Institute for Theoretical Physics — We demonstrate that the many-body localized phase is characterized by the existence of infinitely many local conservation laws. We argue that many-body eigenstates can be obtained from product states by a sequence of nearly local unitary transformation, and therefore have an area-law entanglement entropy, typical of ground states. Using this property, we construct the local integrals of motion in terms of projectors onto certain linear combinations of eigenstates. The local integrals of motion can be viewed as effective quantum bits which have a conserved z-component that cannot decay. Thus, the dynamics is reduced to slow dephasing between distant effective bits. For initial product states, this leads to a characteristic slow power-law decay of local observables, which is measurable experimentally, as well as to logarithmic in time growth of entanglement entropy. We support our findings by numerical simulations of random-field XXZ spin chains. Our work shows that the many-body localized phase is integrable, reveals a simple entanglement structure of eigenstates, and establishes the laws of dynamics in this phase. [1] M. Serbyn, Z. Papic, D. A. Abanin, Phys. Rev. Lett. 111, 127201 (2013).

Dmitry Abanin
Perimeter Institute for Theoretical Physics

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