Thermalization slowing down for weakly nonintegrable many-body dynamics.

Sergej Flach[1]

[1]Institute for Basic Science, Daejeon, South Korea
E-mail: sflach@ibs.re.kr

Abstract: We observe different universality classes in the slowing down of thermalization of many-body dynamical systems upon approaching integrable limits. We identify two fundamentally distinct long-range and short-range classes defined by the nonintegrable perturbation network spanned amongst the (set of countable) actions of the corresponding integrable limit. Weak two-body interactions (nonlinearities) induce long-range networks in translationally invariant lattices. Weak lattice coupling (hopping) instead induce short-range networks. For classical systems we study the scaling properties of the full Lyapunov spectrum. The long-range class results in a single parameter scaling of the Lyapunov spectrum, with the inverse largest Lyapunov exponent being the only diverging time control parameter and the rescaled spectrum approaching an analytical function. The short-range class results in a dramatic slowing down of thermalization and a rescaled Lyapunov spectrum approaching a non-analytic function. An additional diverging length scale controls the exponential suppression of all Lyapunov exponents relative to the largest one. For quantum spin chains we compute ergodization time scales within the framework of the Eigenstate Thermalization Hypothesis and the Lyapunov time from operator growth methods using Krylov Complexity. The comparison of both time scales confirms the existence of the above universality classes for quantum many body dynamics as well.

Keywords: Chaos, Thermalization, Nonintegrable Perturbations, Lyapunov Spectrum, Scaling, Universality, Eigenstate Thermalization Hypothethis, Krylov Complexity, Quantum Spin Chains.