From unitary dynamics to statistical mechanics in isolated quantum systems

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Recently, experiments with ultracold gases have made it possible to study dynamics of (nearly) isolated many-body quantum systems. This has revived theoretical interest on this topic [1]. In generic isolated systems, one expects nonequilibrium dynamics to result in thermalization, namely, equilibration to states in which observables are stationary, universal with respect to widely differing initial conditions, and predictable through the time-tested recipe of statistical mechanics. However, it is not obvious what feature of a many-body system makes quantum thermalization possible, in a sense analogous to that in which dynamical chaos makes classical thermalization possible. Underscoring that new rules could apply in the quantum case, experimental studies in one-dimensional systems have shown that traditional statistical mechanics can provide wrong predictions for the outcomes of equilibration dynamics. We argue that generic isolated quantum systems do in fact equilibrate to states in which observables are described by statistical mechanical [2]. Moreover, we show that time evolution itself plays a merely auxiliary role as thermalization happens at the level of individual eigenstates. We also discuss what happens at integrability points, where a different set of rules apply [3].

References:

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