The Abdus Salam
International Centre
for Theoretical Physics

Conference on Frontiers of Nanoscience
24 August - 1 September 2015, Trieste, Italy

Periodic Driving, Quantum Coherence and Relaxation

Angelo RUSSOMANNO

Bar-Ilan University, Department of Physics
Ramat-Gan, Israel

Abstract:

Recent experimental techniques have allowed to realize, in the so-called cold atomic systems, the quantum-coherent dynamics of many particles undergoing an arbitrary perturbation. Among the many applications, a lot of interest has been attracted by the possibility of studying the evolution of a non-equilibrium state of the Hamiltonian: the so-called quantum-quench protocol. When the spectrum of the Hamiltonian obeys some quite general conditions, local observables relax to a steady state described by the so-called "diagonal ensemble density matrix", constructed using the initial state and the eigenstates of the Hamiltonian. A question dating back to the origins of quantum mechanics is when the steady state is a thermal equilibrium one. It results, indeed, that this happens when the eigenstates are random states obeying the so-called Eigenstate Thermalization condition (ETH), but there is no general theory telling us precisely when this happens. This is quite different from classical thermalization induced by ergodic microscopic dynamics.
In this framework, I will discuss my recent work aimed to generalize these results to the case of periodically driven systems. Noteworthy, even in this case, under conditions on the so-called Floquet spectrum very similar to those of the quantum quench, local observables relax to a steady condition described by the so-called "Floquet-diagonal density matrix". It

is very similar to its quenched counterpart, but the observables in the steady condition are time-periodic: here the energy eigenstates are replaced by the Floquet states, solutions of the Schr ̈odinger equation time- periodic up to a phase.
I will show numerical results on the periodically driven Quantum Ising chain, which never ther- malizes being integrable, and on its fully-connected counterpart, the Lipkin model. This quantum system has a well defined classical limit and it thermalizes to $T = \infty$ whenever the classical dy- namics is ergodic. This thermalization is induced by the Floquet states obeying ETH and being extended in the Hilbert space. I will give also some hint on the results concerning truly quantum non-local objects, like the dynamical fidelity.

References
[1] A. Russomanno, A. Silva, and G. E. Santoro, Phys. Rev. Lett 109, 257201 (2012), 1204.5084.
[2] A. Russomanno, A. Silva, and G. E. Santoro, J. Stat. Mech. p. P09012 (2013), 1306.2805.
[3] S. Sharma, A. Russomanno, G. E. Santoro, and A. Dutta, EPL 106, 67003 (2014), 1402.0758.
[4] A. Russomanno, R. Fazio, and G. E. Santoro, EPL 110, 37005 (2015), 1412.0202.
[5] A. Russomanno, S. Sharma, A. Dutta, and G. E. Santoro, arXiv (2015), quant-ph/1505.02924.