Taming the non-equilibrium

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Complex quantum systems out of equilibrium are not only at the basis of a number of the most intriguing puzzles in physics. This talk will be concerned with recent progress on understanding how quantum many-body systems out of equilibrium eventually come to rest. The first part of the talk will highlight theoretical progress on this question, taking in several ways a quantum information view - employing ideas of Lieb-Robinson bounds, quantum central limit theorems and of concentration of measure (1-4). These findings will be complemented by experimental work with ultra-cold atoms in optical lattices, constituting a dynamical "quantum simulator", allowing to probe physical questions that are presently out of reach even for state-of-the-art numerical techniques based on matrix-product states (5). The last part of the talk will sketch how based on the above ideas, a fully certifiable quantum algorithm preparing Gibbs states can be constructed, complementing quantum Metropolis algorithms (6). (Joint work with C. Gogolin, M. Mueller, T.J. Osborne, A. Flesch, C. Cramer, U. Schollwoeck, I. Bloch, S. Trotzky, Y.A. Chen, A. Riera.).

(1) "Absence of thermalization in non-integrable systems", Phys. Rev. Lett. 106, 040401 (2011).
(2) "Concentration of measure for quantum states with a fixed expectation value", Commun. Math. Phys. 303, 785 (2011).
(3) "A quantum central limit theorem for non-equilibrium systems: Exact local relaxation of correlated states", New J. Phys. 12, 055020 (2010).
(4) "Exact relaxation in a class of non-equilibrium quantum lattice systems", Phys. Rev. Lett. 100, 030602 (2008).
(5) "Probing the relaxation of a strongly correlated 1D Bose gas towards equilibrium", Nature Physics (2011).
(6) "Gibbs states, exact thermalization of quantum systems and a certifiable algorithm for preparing thermal states", arXiv:1102.2389, submitted to Phys. Rev. Lett. (2011).