Equilibration via Gaussification: Theory and experment

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When and by which mechanism do closed quantum many-body systems equilibrate? This fundamental question lies at the very basis of the connection between thermodynamics, many-body quantum mechanics and condensed matter theory.
In the setting of free fermionic evolution, we uncover an underlying mechanism how local memory of the initial conditions is forgotten[1]. Specifically, starting from an initially short range correlated fermionic states which can be very far from Gaussian, we show that if the Hamiltonian provides sufficient transport, the system approaches a state that locally cannot be distinguished from a corresponding Gaussian state. In this way, strongly correlated states, as encountered in the Fermi-Hubbard model, will become locally Gaussian during the evolution under a hopping Hamiltonian, leading to density-density correlations that factor according to Wick's theorem. Our result can be used to infer realistic physical time scales for equilibration and we additionally characterize the equilibrium state, finding an instance of a rigorous convergence to a Generalized Gibbs ensemble.
Recently, a Generalized Gibbs ensemble was observed experimentally on an atomchip experiment[2]. We are currently studying the quantitative predictions of the mean-field model that governs the dynamics of the system as applied to the experimental data which opens a way to assessing observables that are not directly measurable in the setup. Based on a Galerkin discretization approach to the continuum problem we set out to tomographically reconstruct the Gaussian contribution to the steady state, asses the possible non-Gaussian effects and quantify entanglement present in the system.

[1] M. Gluza, C. Krumnow, M. Friesdorf, C. Gogolin, J. Eisert. Phys. Rev. Lett. 117.19 (2016): 190602.

[2] Langen, Tim, et al. Science 348.6231 (2015): 207-211.