# Quantum thermodynamics and superadiabatic control of complex systems

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Quantum thermodynamics is an emerging field with potential applications to nanoscience. At the quantum level, work becomes a stochastic variable, and the work probability distribution is key to characterize a working medium. Complex quantum systems can boost the performance of quantum machines, but their characterization is challenging due to a complexity exponentially scaling with the system size. I will present a characterization of work in driven chaotic quantum systems, which are paradigmatic complex systems, using theory of random matrix Hamiltonians. Specifically, I will discuss the work statistics associated with a sudden quench for arbitrary temperature and system size [1]. In addition, I shall show how work statistics can generally be related to a dynamical problem: the evolution of quantum correlations of an entangled state [2]. Using this mapping, it is possible to connect work statistics to information scrambling, i.e., the spreading of initially localized quantum information across different degrees of freedom in many-body systems, which is a key quantity in the study of quantum chaos.

In a second part, I shall focus on control schemes to fasten the dynamics of the thermodynamic strokes of a quantum engine. Using shortcuts to adiabaticity, I demonstrate the improvement of the output power in compression and expansion strokes, with experimental implementation in a unitary Fermi gas [3]. This superadiabatic control scheme can be extended to open system [4], making possible the fast thermalization of a quantum system.

## References

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[3] S. Deng, A. Chenu, P. Diao, F. Li, S. Yu, I. Coulamy, A. del Campo, and H. Wu, Science Adv. 4:5909 (2018)
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## Figures

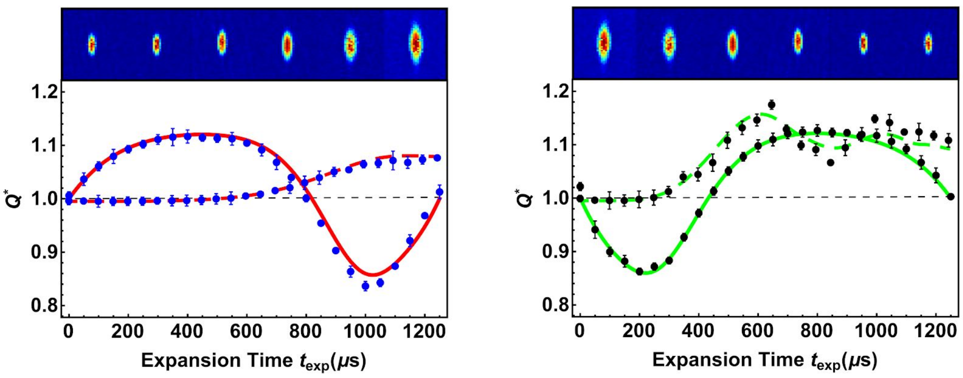


**Figure 1.** Nonadiabatic factor of a driven unitary Fermi gas during an expansion (left) and compression stroke (right) for the reference driving (dashed lines) and local counterdiabatic driving (solid lines). Dots show the corresponding experimental data. Friction is suppressed with the control scheme, giving rise to an increased output power.