Optimal Protocols in non-Markovian Systems

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In stochastic thermodynamics the concepts of classical thermodynamics are applied to single particle trajectories [1]. As a result, quantities like heat and work are no longer sharp values since individual trajectories are subjected to thermal fluctuations. Despite considerable progress in this field, experimental applications of stochastic thermodynamics to non-Markovian baths are rare.

As a specific example, in our experiments we investigate the optimal driving protocol to minimize the work required to translate a colloidal particle confined in a harmonic potential over a given distance in a finite time. Technically, we use an optical tweezer setup that can impose arbitrary and dynamic potential landscapes onto single, but also multiple particles. This is achieved by scanning the laser focus rapidly over the sample using an acusto-optic deflector.

Opposed to Markovian baths where it has been predicted that the optimal protocol is not a linear trap motion but contains symmetrical jumps [2], such protocols are expected to be even more complex in non-Markovian systems. In particular, we are able to resolve the non-equilibration fluctuations that are caused by the strong coupling between the driven colloidal particle and the non-Markovian bath. We will present first experimental and theoretical results.

References:

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