



Efficient information erasure in the underdamped regime

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Abstract :

Landauer's principle states that at least $k_B T \ln 2$ of energy is required to erase a one-bit memory. This bound can be reached experimentally with an underdamped micro-cantilever confined in a tunable double-well potential created by a feedback loop. We apply evolutionary reinforcement learning to a simulation model in order to identify efficient time-dependent erasure protocols for this physical realization of a one-bit memory. We show that these protocols, when applied to the cantilever in the laboratory, are considerably more efficient than our best hand-designed protocols, and allow reliable high-speed erasure, even over many consecutive operations.

We then investigate how the mean work $\langle W \rangle$ needed to erase a bit scales with the protocol duration τ . For τ much longer than the relaxation time of the system t_r , we recover Landauer's bound plus an overhead that scales as $1/\tau$, similar to the overdamped case. For $\tau < t_r$, erasure becomes adiabatic and $\langle W \rangle$ grows more slowly. Finally, we discuss how moving from partial to full control of the potential might further reduce the cost of erasure.