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【13】 Collective Advantages in Finite-Time Thermodynamics

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A central task in finite-time thermodynamics is to minimize the excess or dissipated work W_{diss} when manipulating the state of a system immersed in a thermal bath. We consider this task for an N -body system whose constituents are identical and uncorrelated at the beginning and end of the process. In the regime of slow but finite-time processes, we show that W_{diss} can be dramatically reduced by considering collective protocols in which interactions are suitably created along the protocol. This can even lead to a sublinear growth of W_{diss} with N : $W_{\text{diss}} \propto N^x$ with $x < 1$; to be contrasted to the expected $W_{\text{diss}} \propto N$ satisfied in any noninteracting protocol. We derive the fundamental limits to such collective advantages and show that $x = 0$ is in principle possible; however, it requires long-range interactions. We explore collective processes with spin models featuring two-body interactions and achieve noticeable gains under realistic levels of control in simple interaction architectures. As an application of these results, we focus on the erasure of information in finite time and prove a faster convergence to Landauer's bound.

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