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## Trade-off between speed and cost in shortcuts to adiabaticity

STEVE CAMPBELL, INFN Sezione di Milano & Universita degli Studi di Milano

Recent years have witnessed a surge of interest in the study of thermal nano-machines that are capable of converting disordered forms of energy into useful work. It has been shown for both classical and quantum systems that external drivings can allow a system to evolve adiabatically even when driven in finite time, a technique commonly known as shortcuts to adiabaticity.

It was suggested to use such external drivings to render the unitary processes of a thermodynamic cycle quantum adiabatic, while being performed in finite time. However, implementing an additional external driving requires resources that should be accounted for. Furthermore, and in line with natural intuition, these transformations should not be achievable in arbitrarily short times.

First, we will present a computable measure of the cost of a shortcut to adiabaticity. Using this, we then examine the speed with which a quantum system can be driven. As a main result, we will establish a rigorous link between this speed, the quantum speed limit, and the (energetic) cost of implementing such a shortcut to adiabaticity. Interestingly, this link elucidates a trade-off between speed and cost, namely that instantaneous manipulation is impossible as it requires an infinite cost.