Classical speed limit and finite-time Landauer's bound

Hyunggyu Park

Korea Institute for Advanced Study, Seoul, Korea

Landauer's bound is the minimum thermodynamic cost for erasing one bit of information. As this bound is achievable only for quasistatic processes, finite-time operation incurs additional energetic costs. We find a tight finite-time Landauer's bound by establishing a general form of the classical speed limit. This tight bound well captures the divergent behavior associated with the additional cost of a highly irreversible process, which scales differently from a nearly irreversible process. We also find an optimal dynamics which saturates the equality of the bound. We demonstrate the validity of this bound via discrete one-bit and coarse-grained bit systems. Our work implies that more heat dissipation than expected occurs during high-speed computation.

[1] J.S. Lee, S. Lee, H. Kwon, H. Park, Phys Rev. Lett. 129, 120603 (2022).