Correlations as a Resource in Quantum Thermodynamics

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The presence of correlations can have significant and complex effects. In fact, correlations are valuable resources for many quantum information tasks, and their creation is usually associated to some energetic cost. In this work we study the role of correlations in the thermodynamic process of state formation and work extraction in the single-shot regime. We show that in this context correlations can also be viewed as a resource. In particular we find that, unlike one would expect from standard thermodynamic arguments, the energetic cost of creating multiple copies of a given state can be reduced by allowing correlations in the final state. We provide a full characterization of the set of states that minimize this work of formation for every finite number of copies N. For small N, we show that most of these transformations are irreversible, the energy required for the formation is greater than the extractable one, a generic feature of thermodynamic processes in the single-shot regime. However, we show that as the number of copies increases these states are such that the amount of correlations per copy decreases, and we can recover standard reversible results from thermodynamics in the large N limit. Although we consider in detail the formation of copies, we show that this is a generic feature that applies to arbitrary configurations.