Thermodynamic meaning and power of non-Markovianity

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The connection between thermodynamics and information theory, expressed by Landauer's principle, is a milestone of the physics of the last century. According to this principle, the erasure of information stored in a system requires an amount of work proportional to the entropy of the system. The natural framework to discuss thermodynamics at the quantum level is the theory of open quantum systems. A number of recent results have shown that memory effects arising from strong system-environment correlations may lead to information back-flow, hence prolonging the life of quantum properties. Open systems exhibiting such behaviour are known as non-Markovian. The relation between non-Markovianity and quantum thermodynamics has been until now largely unexplored. Here we establish this missing link by means of Landauer's principle. We show that memory effects control the amount of work that one can extract from an open quantum system. Hence, the work extraction can be optimised via reservoir engineering techniques.