
Fluctuation Limited Free Energy

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Abstract

If we want to treat work as a deterministic quantity we find that for microscopic systems the amount of work we can extract is significantly less than the Von Neumann free energy. Using the setup of system, bath and weight as a work system, we can ask a more general question - "what is the work we can extract from a state if we allow the energy of the work system to fluctuate by no more than a certain amount?". We derive a fluctuation limited free energy which serves to mediate between single-shot thermodynamics and the standard free energy, and suggest applications in accessing the efficiency of realistic nano-machines that cannot withstand energetic fluctuations of arbitrary size. The fluctuation-limited free energy mediates between the min free energy used in single shot thermodynamics and the Von Neumann free energy, and allows us to quantify not only how much work we can extract from a system, but the quality of that work (in terms of the spread of the work distribution).

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