Energetic and entropic footprints of quantum noise

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Despite its strategic interest for the development of scalable computing architectures, the question of the energetic cost of quantum information processing is still in its infancy. Such energetic cost is expected to be tightly related to the amount of quantum noise that should be overcome to perform the computation. A proper framework to conduct these investigations is provided by stochastic thermodynamics, which has analyzed for years the fundamental relations existing between energy, information, and noise. It is a major challenge of quantum thermodynamics to extend these relations in the quantum realm where noise is of purely quantum origin, e.g. stems from quantum measurement and decoherence.

In this talk we will present a new framework for quantum stochastic thermodynamics, that ultimately aims at answering these questions [1,2]. After recalling the general tools of stochastic thermodynamics, we will present the new concept of quantum heat. Quantum heat corresponds to the energetic fluctuations experienced by a quantum system, that are induced by measurement back-action and decoherence. We show that quantum heat provides the proper energy scale to estimate the cost of quantum control and feedback [2]. Finally, we evidence that quantum heat can become a resource in new kinds of genuinely quantum engines, extracting work from quantum measurement [1].

[1] C. Elouard, D. Herrera-Martí, B. Huard, and A. Auffèves, Phys. Rev. Lett.118, 260603 (2017), featured in Nature Research Highlights and Phys.org.
[2] C. Elouard, D. Herrera-Martí, M. Clusel, A. Auffèves, npjQI 3:9 (2017).