Stochastic thermodynamics of autonomous information machines. From Maxwell's demons to cellular sensing

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The framework of stochastic thermodynamics can be applied to Brownian information machines for which information about the system acquired in a measurement is used to extract work from a single heat bath. Fluctuation theorems have been generalized to such feedback-driven non-autonomous machines following an almost standard recipe also allowing to discuss their efficieny and efficiency at maximum power [1]. After briefly recalling this (reasonably well-understood) class, I will describe our recent work dealing with autonomous machines. First, I will discuss a fully stochastic, reversible variant of the demon recently introduced by Mandal and Jarzynski [PNAS 109, 11641, 2012]. Our generalization which includes genuine equilibrium allows to identify Onsager coefficients and the linear response theory of such a demon [2]. Second, within a minimal model for cellular sensing, I will discuss the relation between information-theoretic and thermodynamic entropy production. While one could naively expect the rate of information to be bounded by the thermodynamic cost of acquiring it, based on our new bound on the rate of mutual information for time-continuous processes, I will show that there is no such inequality [3].

[1] US, Rep. Prog. Phys. 75, 126001, 2012.

[2] AC Barato and US, EPL 101, 60001, 2013.

[3] AC Barato, D. Hartich and US, Phys. Rev. E 87, 042104, 2013.