A Pranzo con la Fisica 29/11/12

Verifica Sperimentale del Limite di Landauer

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Verifica Sperimentale del Limite di Landauer

Experimental verification of Landauer's principle linking information and thermodynamics

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In 1961, Rolf Landauer argued that the erasure of information is a dissipative process. A minimal quantity of heat, proportional to the thermal energy and called the Landauer bound, is necessarily produced when a classical bit of information is deleted. A direct consequence of this logically irreversible transformation is that the entropy of the environment increases by a finite amount. Despite its fundamental importance for information theory and computer science, the erasure principle has not been verified experimentally so far, the main obstacle being the difficulty of doing single-particle experiments in the low-dissipation regime. Here we experimentally show the existence of the Landauer bound in a generic model of a one-bit memory. Using a system of a single colloidal particle trapped in a modulated double-well potential, we establish that the mean dissipated heat saturates at the Landauer bound in the limit of long erasure cycles. This result demonstrates the intimate link between information theory and thermodynamics. It further highlights the ultimate physical limit of irreversible computation.

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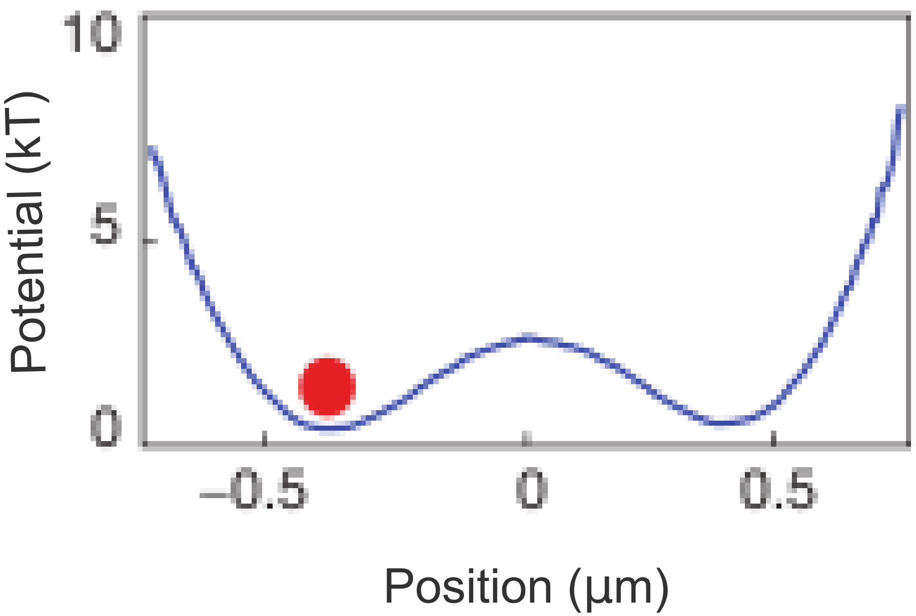
Setup Sperimentale

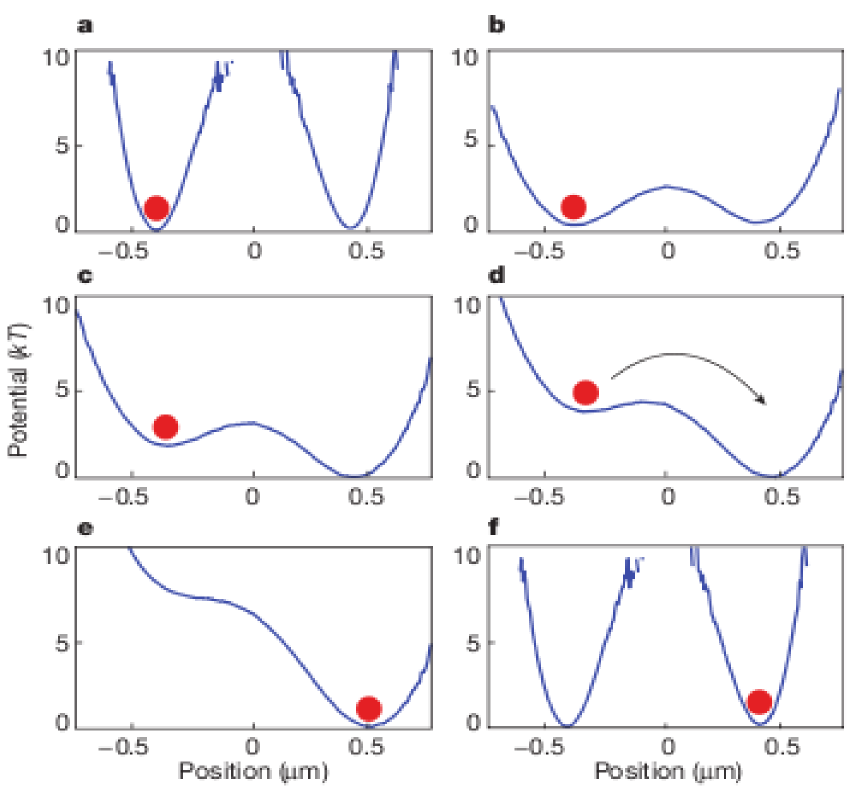
Optical tweezer

- Sfera di vetro:
  R=2µm
- Laser:
  λ=1064nm
  Intensità: [15;48]mW
  Distanza d=1.45µm
  Switch: 10 Khz



$$P(x,I_l)=N\exp[-U_0(x,I_l)/kT] \Rightarrow U_0(x,I_l)=-kT\log[P(x,I_l)/N]$$

Ciclo di Reset e Metodo di Misura

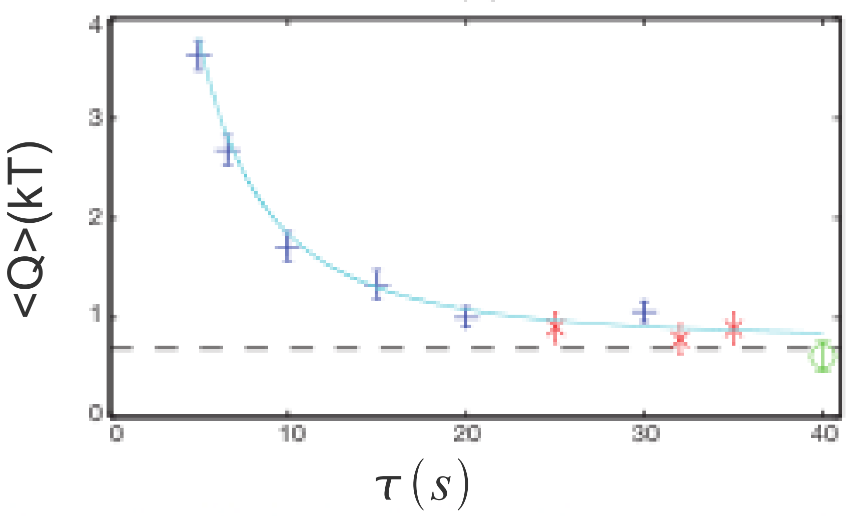


$$F(t) = -\gamma v = F_{max}\, t/\tau$$

Misura su un ciclo
=> ΔE=0 => Q=L

$$Q = \int_0^{\tau} F(t)\,\dot{x}(t)\,dt$$

$$\langle Q \rangle \to_{\tau \to \infty} Q_{landauer}$$



Dubbi

- Il potenziale genera un drag a 10KHz?
- $\langle Q \rangle \leq Q_{landauer} < 0$
- Misura ciclica. $\Delta S \rightarrow 0$ (?)