MAR07-2006-007456

Abstract for an Invited Paper
for the MAR07 Meeting of
the American Physical Society

The nonequilibrium thermodynamics of small systems

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Nonequilibrium behavior is widespread and rich in nature. Yet our understanding of the fundamental principles underlying nonequilibrium behavior is still poor as shown by the fact that non-equilibrium theories tend to be ad-hoc and specific (1). Recently there has been a lot of interest in applying single-molecule techniques to scrutinize nonequilibrium theories (2). The use of new micromanipulation tools in the exploration of the behavior of tiny objects (such as biomolecules and motors) embedded in a thermal environment opens the possibility to investigate how these systems exchange energy with their environment. The study of such questions, nowadays referred to as "Nonequilibrium thermodynamics of small systems," is becoming quite popular among statistical physicists who recognize there new aspects of thermodynamics where large Brownian fluctuations are of pivotal importance as compared to fluctuations in macroscopic (or large) systems (3). Nonequilibrium small systems are characterized by large deviations in work/heat distributions that satisfy some relations called fluctuation theorems. In this talk I will discuss single-molecule experiments where some of these fluctuation theorems have been tested (4).

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