STATISTICAL PHYSICS

**Martingale theory for housekeeping heat**

Which universal thermodynamic properties emerge in a nonequilibrium process, in isothermal conditions at temperature , that result from the violation of detailed balance, and how they may be quantified? The housekeeping heat is the fluctuating heat exchanged between a mesoscopic system and its environment due to the violation of detailed balance. Using the framework of martingale theory widely used in probability theory and finance, we derive a number of universal equalities and inequalities for extreme-value and stopping-time statistics of the housekeeping heat. Our theory provides a quantitative link between minimal models of gambling and financial markets (martingales) and heat fluctuations. The housekeeping heat behaves like a gambler’s fortune in a casino: its expected value in the future is always smaller or equal regardless of its past values. The super-martingale structure of the housekeeping heat implies that certain statistical properties of the housekeeping heat are system-independent, i.e. universal. A particular result of our theory is that the average value of the maximum housekeeping heat that a system absorbs from its environment cannot exceed , with Boltzmann’s constant.

**R. Chétrite, S. Gupta, I. Neri** and **E. Roldán**, Martingale theory for housekeeping heat, *EPL* **124**, 60006 (2018)

**Caption:** “*Traces of fluctuating housekeeping heat (grey lines) behave like downtrend stocks. Our work investigates statistics of extrema (black arrows) against the average tendency*.”