When a fluctuating system at contact with a thermal bath is perturbed by an external means according to a prescribed protocol, the performed work and the exchanged heat are stochastic quantities. From the pioneering works of Jarzynski and Crooks, it is known that the statistical properties of these quantities contain information about the “underlying” equilibrium states of the system along the transformation path. In particular, the work dissipated on average because of the irreversibility of finite-time transformations, is a non-negative quantity (in agreement with the Second Principle of Thermodynamics at the nanoscale) related with the “lag” between the configurational non-equilibrium and equilibrium distributions of the system. The specific amount of dissipation is determined by the kind of transformation protocol, by the kind of energy perturbation, and by the dynamics of the system.

Here we focus on overdamped fluctuating systems subjected to driven cyclic modulations of their internal configurational energy. Starting from thermal equilibrium, a periodic steady state is asymptotically reached as the number of cycles increases. The system’s evolution under perturbation is described by means of the non-stationary Fokker-Planck equation in the Smoluchowski form for diffusive dynamics. By employing a perturbative treatment at the lowest order on the strength of the perturbation, an approximate but explicit relation for the asymptotic average dissipation per cycle is achieved. Such a relation unveils the connection between (i) average dissipation per cycle, (ii) period of the perturbation and (iii) intrinsic fluctuation rates of the unperturbed system taken as reference. Some calculations performed on a toy-model with a single degree of freedom (a rotator with bi-stable potential energy) illustrate the essential features. In particular, the profiles of average dissipation versus the inverse of the perturbation period display local maxima which fall, resembling “stochastic resonance” phenomena, in correspondence of some internal fluctuation rates selected by the specific kind of perturbation. Since the energy dissipated per cycle equals the heat produced, this finding opens the intriguing perspective of devising a sort of “spectroscopic calorimetry” to probe the internal modes/rates of a fluctuating system by measuring the period-dependent rate of heat production under perturbation.