Network analysis for the steady-state thermodynamic uncertainty relation

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We perform network analysis of a system described by the master equation to estimate the lower bound of the steady-state current noise, starting from the level 2.5 large deviation function and using the graph theory approach. When the transition rates are uniform, and the system is driven to a non-equilibrium steady state by unidirectional transitions, we derive a noise lower bound, which accounts for fluctuations of sojourn times at all states and is expressed using mesh currents. This bound is applied to the uncertainty in the signal-to-noise ratio of the fluctuating computation time of a schematic Brownian computation plus reset process [1,2] described by a graph containing one cycle. Unlike the mixed and pseudo-entropy bounds that increase logarithmically with the length of the intended computation path, this bound depends on the number of extraneous predecessors and thus captures the logical irreversibility [3].

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