INSTITUT DE PHYSIQUE ET CHIMIE DES MATERIAUX DE STRASBOURG

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Séminaire AXE 1 - Sciences et Matériaux Quantiques

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Thermodynamic consistency of noise models in electrical circuits: from Brillouin's paradox to nonlinear stochastic networks

The description of noise and dissipation in electrical circuits is a long-standing problem. Fluctuations induced by an ohmic resistor are well described by the Johnson-Nyquist model, leading to a relationship analogous to Einstein's for Brownian motion, linking the diffusion coefficient to the value of the resistance. However, when considering a resistive component with a nonlinear current-voltage characteristic, adding a fluctuation term is not as simple as in the linear case. In fact, the naive approach of writing the simplest possible Langevin equation will generally lead to a conflict with the second law of thermodynamics: this is Brillouin's paradox. However, it is possible to construct and classify an entire landscape of thermodynamically consistent models by reexamining the principle of detailed balance.

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