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Thermodynamics of Precision in Open Quantum Systems

Friday, 12 December 2025 10:20 (50 minutes)

In this talk, I will present recent progress on the thermodynamics of precision in open quantum systems, spanning both Markovian and non-Markovian regimes. For Markovian dynamics, quantum extensions of thermokinetic uncertainty relations reveal how coherence can relax classical bounds, allowing enhanced precision at reduced thermodynamic cost [1]. Going beyond the weak-coupling and memoryless limit, I will introduce universal precision bounds valid for general open quantum systems subjected to two-point measurements [2]. These bounds demonstrate that the relative fluctuations of time-antisymmetric currents are limited not only by entropy production but also by a forward-backward asymmetry term, which reflects the time-reversal symmetry breaking caused by dynamical factors such as quantum coherence and quantum entanglement. For generic observables, precision is instead constrained by a generalized activity term, which quantifies changes in the environment.
[1] T. Van Vu, PRX Quantum 6, 010343 (2025).
[2] T. Van Vu, R. Honma, and K. Saito, arXiv:2508.21567.

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