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Stochastic Thermodynamics in Open Systems at Sub-Kelvin Regimes

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Abstract

This working note examines fluctuation theorems and entropy production bounds in driven mesoscopic junctions coupled to structured bosonic reservoirs below 100 mK. Using a time-local non-Markovian master equation combined with quantum-jump trajectory sampling, we evaluate deviations from weak-coupling Landauer limits under finite-time modulation. The numerical framework reproduces heat-current variances in superconducting normal-metal tunnel junctions while maintaining complete positivity of the reduced density operator.

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