

Microscopic reversibility in the quantum regime

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The principle of microscopic reversibility lies at the core of fluctuation theorems, which have extended our understanding of the second law of thermodynamics to the statistical level. With the development of quantum information science, it has been actively studied how quantum coherence changes the laws of thermodynamics. We propose and experimentally test a quantum modification of the principle of microscopic reversibility, a symmetry relation between forward and backward state transitions when a system is interacting with a thermal heat bath. We show that this quantum modification plays a critical role in the low-temperature limit, while the quantum-to-classical transition occurs at high temperatures.

[1] H. Kwon and M. S. Kim, *Phys. Rev. X* **9**, 031029 (2019).

[2] M. Bellini, H Kwon, N Biagi, S Francesconi, A Zavatta, M. S. Kim, *Phys. Rev. Lett.* **129**, 170604 (2022).