Contribution ID: **6** Type: **Poster presentation**

Harnessing dissipation for enhanced performance and precision in quantum thermal machines

Quantum technologies rely on the precise manipulation of delicate quantum states and correlations, which are often vulnerable to the influence of the environment. While dissipation is usually seen as detrimental, we show that a regime of strong dissipation can be harnessed to improve performance and precision (low relative fluctuations) in quantum thermal machines, devices capable of performing useful thermodynamic tasks, such as delivering power, cooling, or heating. We show that the presence of a common environment—which mediates non-trivial correlations in the working medium of a heat engine (two non-interacting quantum harmonic oscillators) and induces dissipation—can enhance power and efficiency compared to an analogous configuration of two independent engines working in parallel. Remarkably, this collective advantage is striking in the regime of strong dissipation, where independent engines cannot deliver any useful power [1]. Furthermore, we reveal how such a regime of strong dissipation induces synchronization between the two quantum harmonic oscillators, and how this synchronization is a necessary ingredient for achieving precise and finite local work currents, violating the associated thermodynamic uncertainty relations [2]. Our results thus offer new perspectives for developing efficient quantum technologies, with possible applications extending beyond energy-related tasks: (i) Investigating dissipation-induced collective advantages and their link to multipartite quantum correlations in larger systems; (ii) Leveraging synchronization mechanisms to obtain finite and precise power in quantum circuits; (iii) Exploring the impact of nonlinearities, in particular in hybrid quantum systems such as oscillator-qubit ones.

[1] AVS Quantum Sci. 6, 025001 (2024)
[2] Quantum Sci. Technol. 9, 045032 (2024)

Theme

Theme 1. Energy advantage and cost of quantum technology

Primary authors: CARREGA, Matteo (CNR-SPIN); RAZZOLI, Luca (Università degli Studi dell'Insubria); ERDMAN, Paolo Andrea (Freie Universität Berlin); CAVALIERE, Fabio (University of Genova); BENENTI, Giuliano (Università degli Studi dell'Insubria); SASSETTI, Maura (University of Genova)

Presenter: RAZZOLI, Luca (Università degli Studi dell'Insubria)

Track Classification: Theme 1. Energy advantage and cost of quantum technology