Contribution ID: **107** Type: **Invited talk**

Entanglement and dynamical scaling laws in quantum superabsorption

Friday, 17 April 2026 14:30 (20 minutes)

In this talk, we explore the superabsorption effect in quantum batteries, which exploit collective quantum resources to surpass the limits of classical energy storage and power delivery. We analyse N-qubit cavity-coupled quantum batteries governed by Dicke and Tavis-Cummings models under Gaussian driving and open-system dynamics. Finite-size scaling laws $O(N) \sim N^{\alpha}$ demonstrate an optimal region of relaxation and dephasing in which coherent driving stabilises entanglement entropy growth for thermodynamic observables (maximum energy Emax, charging time τ, and maximum power Pmax) and for qubit and cavity entanglement entropies. The Dicke model exhibits entropy-suppressed extensive behaviour, while the Tavis-Cummings model achieves super-extensive scaling ($\alpha_{\text{Emax}} \in [1.08, 1.26]$, $\alpha_T \simeq -0.49$, $\alpha_{\text{Pmax}} \in [1.57, 1.73]$), supported by qubit-cavity entanglement.

We demonstrate that dissipation can act as a stabiliser source, yielding scaling benchmarks relevant to several experimental platforms. Our findings connect entanglement, dissipation-enhanced scaling laws, and superabsorption, outlining a pathway towards scalable quantum batteries that offer practical quantum advantage.

Work in collaboration with Juan D. Álvarez

Primary author: REINA, John Henry (Universidad del Valle)

Presenter: REINA, John Henry (Universidad del Valle)

Session Classification: Invited Talks

Track Classification: Statistical Physics