

Francesco Campaioli

Monash University, Melbourne

Enhancing the Charging Power of Quantum Batteries

Abstract: Can collective quantum effects make a difference in a meaningful thermodynamic operation? Focusing on energy storage and batteries, we demonstrate that quantum mechanics can lead to an enhancement in the amount of work deposited per unit time, i.e., the charging power, when N batteries are charged collectively. We first derive analytic upper bounds for the collective quantum advantage in charging power for two choices of constraints on the charging Hamiltonian. We then demonstrate that even in the absence of quantum entanglement this advantage can be extensive. For our main result, we provide an upper bound to the achievable quantum advantage when the interaction order is restricted; i.e., at most k batteries are interacting. This constitutes a fundamental limit on the advantage offered by quantum technologies over their classical counterparts.