Quantum charging advantage in superconducting solid-state batteries

Quantum battery, as a novel energy storage device, offers the potential for unprecedented efficiency and performance beyond the capabilities of classical systems, with broad implications for future quantum technologies. In this talk I'll present, a recent experiment demonstrating quantum charging advantage (QCA) in a scalable solid-state quantum battery [1]. More specifically, we show how double-xcitation Hamiltonians for two-level systems promote scalable QCA with standard methods. We effectively implement the collective evolution of quantum systems with 2 up to 12 battery cells in a superconducting quantum processor, and study the performance of quantum charging compared to its uncorrelated classical counterpart. The model considered is a linear chain of superconducting transmon qubits with only nearest-neighbor and pairwise interactions, which constitute the simplest model of a multi-cell quantum battery. Our results empirically realize substantial QCA without the necessity of adopting long-range and many-body interactions and showcase the quantum features of the QB charging processes with measurements of non-zero coherent ergotropy, incoherent ergotropy and entanglement, revealing a promising prospect for further developments of efficient and experimentally feasible protocols for QCA.

[1] C.-K. Hu et al, Soon on arXiv, accepted for publication in Physical Review Letters.