Topologically Frustrated Quantum Batteries: From Theoretical Advantage to Experimental Realization

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Quantum batteries have emerged as a promising paradigm for energy storage at the quantum scale, where collective effects can lead to performance advantages beyond classical limits. In this talk, I present a unified theoretical and experimental framework for quantum batteries based on topologically frustrated systems.

On the theoretical side, I show that topological frustration provides a robust mechanism to enhance the efficiency and performance of quantum batteries, by inducing non-trivial collective behavior and constraining the system dynamics in a way that favors energy storage and extraction.

Building on these results, I then present an experimental implementation that realizes the key ingredients of topologically frustrated quantum systems. This platform constitutes a first concrete step toward the physical realization of the theoretical quantum battery models, demonstrating that the required structures are not only theoretically advantageous but also experimentally accessible.

Taken together, these results establish a direct bridge between theoretical proposals and experimental feasibility, opening a realistic route toward the development of quantum batteries based on frustrated quantum systems.