International Conference on Quantum Energy 2025 hosted by Dipartimento di Fisica e Astronomia Galileo Galilei an event by ICQE

Contribution ID: **45** Type: **Oral presentation**

Controlled Optical Charging of a Symmetry-Protected Open Quantum Battery

Thursday 5 June 2025 17:45 (20 minutes)

Quantum batteries, which store and transfer energy at the quantum level, have attracted significant interest for their potential applications in energy-efficient quantum technologies. Previous studies [1,2] demonstrated that an exciton could be stored indefinitely in a symmetry-protected dark state of an open quantum battery model, preventing environment-induced losses. However, an open question remained: how to efficiently prepare—or charge—the battery in this dark state. In this work, we address this challenge by employing a controlled optical charging mechanism. Specifically, we initialize the quantum battery in its ground state and excite it using a continuous-wave laser field to an intermediate bright state located above the target dark state. By leveraging a carefully engineered combination of coherent quantum dynamics and controlled dissipation, we drive the system toward the dark state. Once the laser field is turned off after the dark state has been fully populated, the battery remains in this symmetry-protected state, enabling indefinite energy storage. Our results offer a pathway for practical implementation of quantum batteries and contribute to the broader understanding of energy storage and transfer in open quantum systems.

References
[1] Liu, J., Segal, D., and Hanna, G. "Loss-free excitonic quantum battery"J. Phys. Chem. C 123, 18303-18314 (2019).
[2] Liu, Z and Hanna, G. "Population and energy transfer dynamics in an open excitonic quantum battery" Molecules 29, 889 (2024).

Theme

Theme 3. Theoretical and experimental methods for quantum effects in energy processes

Primary author: Prof. HANNA, Gabriel (University of Alberta)

Co-authors: Prof. MAHDIAN, Mahmoud (University of Tabriz); Ms KHODADAD, Zohreh (University of Alberta)

Presenter: Prof. HANNA, Gabriel (University of Alberta)

Track Classification: Theme 2. Quantum effects in energy processes and materials