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## Nonreciprocal Quantum Batteries

Nonreciprocity, arising from the breaking of time-reversal symmetry, has become a fundamental tool in diverse quantum technology applications. It enables directional flow of signals and efficient noise suppression, constituting a key element in the architecture of current quantum information and computing systems. Here we explore its potential in optimizing the charging dynamics of a quantum battery. By introducing nonreciprocity through reservoir engineering during the charging process, we induce a directed energy flow from the quantum charger to the battery, resulting in a substantial increase in energy accumulation. Despite local dissipation, the nonreciprocal approach demonstrates a fourfold increase in battery energy compared to conventional charger-battery systems.

This effect is observed in the stationary limit and remains applicable even in overdamped coupling regimes, eliminating the need for precise temporal control over evolution parameters. Our result can be extended to a chiral network of quantum nodes, serving as a multi-cell quantum battery system to enhance storage capacity. The proposed approach is straightforward to implement using current state-of-the-art quantum circuits, both in photonics and superconducting quantum systems. In a broader context, the concept of nonreciprocal charging has significant implications for sensing, energy capture, and storage technologies or studying quantum thermodynamics.

### Theme

Theme 2. Quantum effects in energy processes and materials

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