Locally driven spin collision battery

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Quantum batteries are an emerging field of research that explores the use of quantum mechanics to enhance the storage and transfer of energy [1]. Unlike classical batteries, quantum batteries exploit the principles of superposition and entanglement to increase their efficiency and capacity [2]. One promising model for quantum batteries is the collision model, which involves the transfer of energy between two quantum systems that collide with each other [3]. In this research, we were inspired by the collision model, and we are considering two spin systems that contain three spins each. Both systems are fully interacting graphs but only collide by interacting one spin from each graph. As stated, collision model is only an inspiration, the battery dynamics are solved via numerical integration of Liouville-von Neumann equation. Also adding a time dependent driving which can induce a phase transition. Our work also aims to address the question of whether it is possible to induce a phase transition in a non-uniformly interacting Hamiltonian within a finite time frame using finite-time quantum control. The shortcut to adiabaticity (STA) method was considered as a potential candidate for such control, as it has been shown to be effective in driving many quantum systems [4-6]. These attempts have been limited by the issues of level crossings and degeneracy, which are problematic for STA [6]. It is worth noting that level crossings are unavoidable in phase transitions [6]. In order to address issues related to degeneracy and level crossings, we have devised an approach that draws inspiration from collision models. This research demonstrates that incorporating non-uniformity into battery design has the potential to enhance battery performance. We have utilized work output and ergotropy as performance metrics and presented statistical information on different non-uniform Hamiltonians [2].

References

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