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Deterministic Generation of Linear Photonic Cluster States with Semiconductor Quantum Dots: A Detailed Comparison of Different Schemes

Nikolas Köcher[1], David Bauch[1], Nils Heinisch[1], Stefan Schumacher[1,2]
[1]Paderborn University, Paderborn, Germany. [2]University of Arizona, Tuscon, USA

Abstract

Graph and cluster states are types of multipartite entangled states with applications in quantum communication [1] and measurement-based quantum computation [2].

We theoretically investigate and compare different schemes for the deterministic generation of linear photonic cluster states using spins in charged semiconductor quantum dots with strong Purcell enhancement. The schemes differ in the method used for spin control and whether the emitted photonic qubits are polarization or time-bin encoded. We efficiently track the fidelity and the useable length of the cluster states by calculating the expectation values of their stabilizer generators based on photonic multi-time correlation functions $G^{(n)}(t_1, t_2, \ldots)$, assessing their actual state fidelity beyond the calculation of gate fidelities [3].

We find that the performance of the schemes and which scheme is optimal strongly depend on the cavity environment and the coherence time of the spin qubit.

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