Single-NV-center quantum memory for a superconducting flux qubit via ferromagnet

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**Abstract**

We propose a quantum memory scheme to transfer and store the quantum state of a superconducting flux qubit (FQ) into the electron spin of a single nitrogen-vacancy (NV) center via yttrium iron garnet (YIG), a ferromagnet. Unlike an ensemble of NV centers, the YIG engaged in the state transfer process can enhance by a collective effect the effective FQ-NV-center coupling strength to MHz level but without introducing additional appreciable decoherence. We derive the effective coupling Hamiltonian between the FQ and the NV center by tracing out the degrees of freedom of the YIG and simulate the transfer, storage and retrieval protocol taking into account the spontaneous decay and pure dephasing effect. Using the realistic experimental parameters for the FQ, NV center and YIG, we find that a long storage time of 10 ms with combined transfer storage and retrieval fidelity higher than 0.9 can be achieved. This hybrid system not only gives a quantum state memory architecture for FQ’s but also provides a way to couple other systems more strongly to a single NV center.