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Quantum memory operations in a flux qubit - spin ensemble hybrid system[1] S. SAITO, X. ZHU, NTT Basic Research Laboratories, R. AMSUSS, TU Wien, Y. MATSUZAKI, K. KAKUYANAGI, NTT Basic Research Laboratories, T. SHIMO-OKA, N. MIZUOCHI, Osaka University, K. NEMOTO, National Institute of Informatics, W. J. MUNRO, NTT Basic Research Laboratories, K. SEMBA, National Institute of Informatics — Superconducting quantum bits (qubits) are one of the most promising candidates for a future large-scale quantum processor. However for larger scale realizations the currently reported coherence times of these macroscopic objects (superconducting qubits) has not yet reached those of microscopic systems (electron spins, nuclear spins, etc). In this context, a superconductor-spin ensemble hybrid system has attracted considerable attention. The spin ensemble could operate as a quantum memory for superconducting qubits. We have experimentally demonstrated quantum memory operations in a superconductor-diamond hybrid system [1]. An excited state and a superposition state prepared in the flux qubit can be transferred to, stored in and retrieved from the NV spin ensemble in diamond. From these experiments, we have found the coherence time of the spin ensemble is limited by the inhomogeneous broadening of the electron spin (4.4 MHz) and by the hyperfine coupling to nitrogen nuclear spins (2.3 MHz). In the future, spin echo techniques could eliminate these effects and elongate the coherence time. Our results are a significant first step in utilizing the spin ensemble as long-lived quantum memory for superconducting flux qubits. [1] S. Saito, et al., Phys. Rev. Lett. 111, 107008 (2013).

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