MAR17-2016-001728

Abstract for an Invited Paper
for the MAR17 Meeting of
the American Physical Society

Collective coupling in hybrid superconducting circuits[1]

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Hybrid quantum systems utilizing superconducting circuits have attracted significant recent attention, not only for quantum information processing tasks but also as a way to explore fundamentally new physics regimes. In this talk, I will discuss two superconducting circuit based hybrid quantum system approaches. The first is a superconducting flux qubit - electron spin ensemble hybrid system in which quantum information manipulated in the flux qubit can be transferred to, stored in and retrieved from the ensemble. Although the coherence time of the ensemble is short, about 20 ns, this is a significant first step to utilize the spin ensemble as quantum memory for superconducting flux qubits. The second approach is a superconducting resonator - flux qubit ensemble hybrid system in which we fabricated a superconducting LC resonator coupled to a large ensemble of flux qubits. Here we observed a dispersive frequency shift of approximately 250 MHz in the resonators transmission spectrum. This indicates thousands of flux qubits are coupling to the resonator collectively. Although we need to improve our qubits inhomogeneity, our system has many potential uses including the creation of new quantum metamaterials, novel applications in quantum metrology and so on.

[1]This work was partially supported by JSPS KAKENHI Grant Number 25220601.