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Strong coupling of ferromagnetic magnons to a microwave resonator YUTAKA TABUCHI, SEIICHIRO ISHINO, TOYOFUMI ISHIKAWA, REKISHU YAMAZAKI, KOJI USAMI, Research Center for Advanced Science and Technology, The University of Tokyo, Japan, YASUNOBU NAKAMURA, Research Center for Advanced Science and Technology, The University of Tokyo, Japan, Center for Emergent Matter Science, RIKEN, Japan — Coherent coupling between paramagnetic spin ensembles and superconducting quantum circuits is now widely studied for quantum memories and microwave-to-optical quantum transducers. Since those applications require strong coupling and sufficiently long coherence time simultaneously, collective excitation (magnon) in yttrium iron garnet (YIG), a typical ferromagnetic insulator, is an alternative promising candidate. The material known to have high spin density ($2\times10^{21}\mathrm{cm}^{-3}$) and narrow ferromagnetic resonance (FMR) linewidth ($\sim$ 45 kHz at 4.2 K). As a first step towards quantum state transfer from superconducting qubits to YIG magnons, we demonstrate strong selective coupling between a 3D microwave resonator and the uniform magnon mode. In the experiment, we used a YIG sphere with a diameter of 0.75 mm, mounted in a copper resonator and cooled down to 10 mK. We clearly observed the normal mode splitting between the magnon mode and the resonator in the transmission spectrum. It survived even at the weakest power level where the average photon number is below one. The coupling strength, cavity and FMR linewidth were 82 MHz, 2.2 MHz, and 11.5 MHz, respectively. A coupling scheme of a superconducting qubit to the YIG magnons is also discussed.

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