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Single artificial-atom maser

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Masers and lasers usually involve ensemble of atoms to be excited and stimulated for emission. As those atoms are only weakly coupled to the cavity mode, a large number of atoms and strong pumping are needed for lasing in order to overcome the cavity loss and the relaxation of atoms due to spontaneous emission into other modes. However, when the coupling becomes strong even a single atom is enough for lasing, as have been demonstrated with atoms in microwave/optical cavities. We have realized an analogous single artificial-atom maser in a superconducting circuit [1]. Josephson-junction charge qubit is used as an artificial atom with a large dipole. The qubit is coupled to a superconducting Nb coplanar-waveguide resonator at around 10 GHz and with a quality factor of 7600. The coupling strength between the qubit and the resonator is 80 MHz. Population inversion is generated by current injection: A current is injected through a voltage-biased electrode attached to the charge qubit via a highly resistive tunnel junction. In the so-called Josephson-quasiparticle process, the qubit is pumped incoherently to the upper state and emits photon into the cavity. This work is in collaboration with O. Astafiev, K. Inomata, A.O. Niskanen, T. Yamamoto, Yu. A. Pashkin, and J.S. Tsai. This work has been supported by RIKEN Frontier Research System and CREST-JST.

Reference: [1] O. Astafiev *et al.*, Nature **449**, 588 (2007).