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Observation of a single rare-earth ion in a crystal by electric-field modulation spectroscopy for a readout of a nuclear-spin qubit KOUICHI ICHIMURA, HAYATO GOTO, SATOSHI NAKAMURA, MAMIKO KUJIRAOKA, Frontier Research Laboratory, Corporate Research & Development Center, Toshiba Corporation — Nuclear spin states of rare-earth-metal ions in a crystal are known as good candidates for qubits in solids because of their long coherence time and their good controllability by lights. In the frequency-domain quantum computer (FDQC), nuclear spin states of the ions are employed as qubits defined in a frequency domain, and interaction between the qubits is mediated by a single cavity mode. In FDQC we can use adiabatic passage with dark states to perform single-qubit gates and two-qubit gates [1], and a single-qubit gate using adiabatic passage has been demonstrated [2]. For two-qubit gates, quantum states of qubit ions need to be read out and operated individually. In order to observe a single ion in a crystal, we studied modulated signals due to ions in a cavity-mode spectrum of a monolithic optical cavity made of Pr^{3+}:Y_2SiO_5. Owing to the cavity enhancement and the electric-field modulation spectroscopy, signals which are likely due to individual ions (statistical fine structure in an inhomogeneously broadened optical trandition) were observed.

[1] K. Ichimura, Opt. Commun., 196, 119 (2001).
[2] H. Goto and K. Ichimura, Phys. Rev. A, 75, 033404 (2007).

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