High cooperativity coupling to nuclear spins on a circuit quantum electrodynamics architecture

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Nuclear spins are candidates to encode qubits due to their isolation from magnetic noise. Yet, their weak coupling to external stimuli makes them hard to integrate into circuit-QED architectures, the leading technology for solid-state quantum processors. Here[1], we study the coupling of Yb^{3+} nuclear spin states in a Yb(trensal) molecule[2] to LC superconducting resonators with characteristic frequencies spanning the range of nuclear and electronic spin transitions. An external magnetic field is used to tune the nuclear and electronic spin transitions on resonance with the resonators. Our results show strong coupling of cavity photons to electronic spin states and a high-cooperativity coupling in the case of nuclear spins[1]. The nuclear spin-photon coupling is enhanced by the hyperfine interaction with the effective electronic spin. Attaining the coherent coupling regime is a requisite to perform non-demolition read-out of the electronic and nuclear spin states[3]. This technology can enable the implementation of quantum error correction protocols[4], in crystals of molecular spin qudits[2,5].

References

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Figures

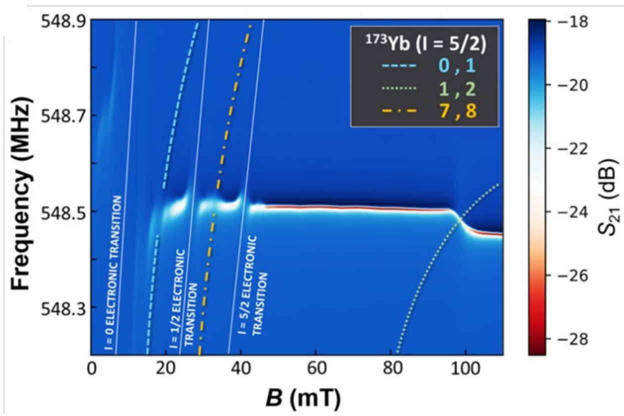

Figure 1: Transmission as a function of frequency and external magnetic field showing several Yb(trensal) spin transitions coupled to a superconducting resonator. Among these transitions, the coloured ones are nuclear spin transitions.