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Dispersive readout of molecular spin qubits

Magnetic molecules are attractive candidates to encode spin qubits [1,2]. We have performed the first experiments to test the dispersive readout of qubits encoded in the spin states of a magnetic molecules by means of a superconducting circuit [3]. We couple our molecules to lumped-element resonators (LERs) fabricated at the Centro of Astrobiología (CAB) [4]. Sweeping the external magnetic field magnetic, we can change the detuning between the frequency of operation of the qubit and the resonator frequency. If the detuning is larger than the qubit-resonator coupling, we can perform a non-demolition measurement of the state of the qubit by monitoring changes in the resonator's frequency.
As a starting point, we chose the simplest system possible: PTMr, a free radical (Fig. 1a) with spin 1/2 [5] and the qubit states encoded in its two spin projections. We show that the absorption spectrum of the radical can be obtained, at a given field, by sweeping the frequency of a driving electromagnetic pulse and then measuring the state of the resonator (Fig. 1b). The spectrum width comes from the inhomogeneous broadening of the sample. By increasing the time delay between the pump pulse and the readout measurement we have determined the longitudinal relaxation time T1, which becomes as long as 10-20 s at very low temperatures (Fig. 1c). In parallel, we have tested the enhancement of the coupling between this sample and the LER by making a constriction in the inductor of the resonator. The results from the decay with T1 agree with the distribution of spin-photon couplings generated by a small nano-constriction.

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