Yu-Shiba-Rusinov Qubit

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Magnetic impurities coupled to s-wave superconductors lead to spin polarized in-gap states, the so called Yu-Shiba-Rusinov (YSR) states. The quantum states stemming from two nearby impurities (dimer) pertain to an effective two-level system which we propose to use as a qubit, the building block of a quantum computer. Using a time-dependent Green function approach, we derive an effective Hamiltonian describing the YSR qubit evolution as a function of distance between the impurities, their relative orientations, and their dynamics. We then employ both numerical and analytical methods to show that the YSR qubit states can be both controlled and read out efficiently utilising the dynamics of the magnetic impurities that engenders it. Finally, we address the effect of the spin noises originating from the classical impurities on the coherence properties of the YSR qubit, and show a robust qubit behaviour for a wide range of experimentally relevant parameters.

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