Microwave quantum memory at unit cooperativity

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Abstract

Spin ensembles coupled to superconducting resonators represent a promising platform for microwave quantum memory implementation. An appropriate coupling between the spin ensemble and the resonator is required to realise efficient state transfer. This efficiency is usually characterized by the cooperativity C and maximized for C=1 (1). In this work, we use an NbN spiral superconducting resonator and 171Yb spins in a YSO crystal (2) to tune to unit cooperativity for high and low power input signals. The cooperativity is measured under real conditions of quantum memory protocols (3). Subsequently, we delve into round-trip efficiency calculations and discuss the ways to reach high efficiency at zero field: change of host crystal to CaWO4 (4) for longer relaxation times, optimal coupling to resonator, and suppression of unwanted emissions.
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(2) J Alexander 2023, Doctoral thesis.
(3) J O'Sullivan et al 2022 Phys. Rev. X. 12, 041014
(4) A Tiranov et al 2025 arXiv:2504.01592

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