Magnetic resonance with quantum microwaves

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Résumé

The detection and characterization of paramagnetic species by electron-spin resonance (ESR) spectroscopy has numerous applications in chemistry, biology, and materials science [1]. Most ESR spectrometers rely on the inductive detection of the small microwave signals emitted by the spins during their Larmor precession into a microwave resonator in which they are embedded. Using the tools offered by circuit Quantum Electrodynamics (QED), namely high quality factor superconducting micro-resonators and Josephson parametric amplifiers that operate at the quantum limit when cooled at 20mK [2], we investigate magnetic resonance in a new regime where the quantum nature of the microwave field plays a role. In particular, the spin detection sensitivity is strongly enhanced [3,4] and spin relaxation is governed by spontaneous emission through the cavity [5]. In this talk we will consider applications of this new regime to ultra-high-sensitivity nuclear spin detection [6] and electron spin hyperpolarization.

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