Suppression of Decoherence by Using Quantum Zeno Effect

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Projective measurements are an essential element of quantum mechanics. In most cases, they cause an irreversible change of the quantum system on which they act. However, measurements can also be used to stabilize quantum states from decay processes, which is known as the Quantum Zeno Effect (QZE) \([1]\). Here, we demonstrate this effect for the case of superposition states of nuclear spin qubits, using an ancilla to perform the measurement \([2]\). As a result, the quantum state of the qubit is protected against dephasing. To our best knowledge, this is the first demonstration to suppress the dephasing by QZE.

We employ a \(^{13}\)C-labeled chloroform (Cambridge Isotopes) diluted in \(d_6\)-acetone with a 303 mM concentration for a proof-of-principle demonstration. See, the inset of the right figure. The experiments are carried out using a JEOL ECA-500 spectrometer at room temperature. Unlike previous NMR experiments demonstrating QZE \([3]\), we do not employ a field gradient to simulate measurements. The dephasing of the \(^{13}\)C nuclear spin is introduced through the proton by adding a magnetic impurity (47.7 mM of Iron(III) acetylacetonate). This dephasing of the \(^{13}\)C spin is suppressed, as shown in the right figure, by frequent measurements with the proton (entanglement with \(^{13}\)C and decoherence of the proton \([4, 5]\)).

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