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On Readout of Vibrational Qubits using Quantum Beats
DMYTRO SHYSHLOV, DMITRI BABIKOV, Marquette Univ — Readout of the final states of qubits is a crucial step towards implementing quantum computation in experiment. In this theoretical work we explore the process of readout from vibrational qubits in thiophosgene molecule, SCCl2, using quantum beat oscillations. The quantum beats are measured by first exciting the superposition of the qubit-encoding vibrational states to the electronically excited readout state with variable time delay pulses. The resulting oscillation of population of the readout state is then detected as a function of time delay. In principle, fitting the quantum beat signal by an analytical expression should allow extracting the values of probability amplitudes and the relative phases of the vibrational qubit states. However, we found that if this procedure is implemented using the standard analytic expression for quantum beats, a non-negligible phase error is obtained. We discuss the origin and properties of this phase error, and propose a new analytical expression to correct the phase error. The corrected expression fits the quantum beat signal very accurately. We now have a practical approach to read out the final state of vibrational qubits in experiments by combining the analytic expression for fitting with numerical modelling of the readout process.

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