Quantum process tomography of energy and phase relaxation in adaptive bases

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Quantum process tomography tends to be very time-consuming when multiple degrees of freedom are studied simultaneously. We present a method of efficient quantum process tomography to estimate the energy and phase relaxation rates in qubits. In a sequence of measurements, the method adaptively chooses the basis for the next measurement based on the previously obtained measurement outcomes in the sequence. This is accomplished by applying Bayesian inference. We adopt sequential Monte-Carlo approach to perform the updates of the Bayesian probability distributions and make use of a fast numerical implementation of the algorithm. We compare the performance of our method to conventional offline strategies (that are implemented after experimental data collection) and illustrate how our method can speed up quantum process tomography.