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Real-time state estimation and feedback control of an oscillating qubit via self-fulfilling prophecy (SFP)

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ABSTRACT:

We present protocols for feedback control and stabilization of a single qubit undergoing Rabi oscillations. Using a hybrid quantum-classical Bayesian estimation technique we simulate monitoring of the dynamical parameter (Rabi frequency) of the governing Hamiltonian in real-time. We numerically demonstrate feedback control of the system parameter using a classical proportional-integral feedback control scheme and show that by implementing a unitary reversal of the back-action of the weak measurement the loop response time is dramatically reduced. This reversal is chosen by assuming the system is already executing the targeted dynamics, an approach called self-fulfilling prophecy. In addition, self-fulfilling prophecy reduces measurement induced noise, leading to stabilized dynamics.