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Single shot quantum state estimation via continuous measurement in a strong back-action regime ROBERT COOK, IVAN DEUTSCH, University of New Mexico — Quantum state reconstruction is a fundamental task in quantum information science. The standard approach employs many projective measurements on a series of identically prepared systems in order to collect sufficient statistics of an informationally complete set of observables. An alternative procedure is to reconstruct quantum state by performing weak continuous measurement collectively on an ensemble, while simultaneously applying time varying controls [1]. For known dynamics, the measurement history determines the initial state. In current implementations the shot noise of the probe dominates over projection noise so that measurement-induced backaction is negligible. We generalize this to the regime where quantum backaction can play a significant role, even for small numbers of particles. Using the framework of quantum filtering theory, we model the reconstruction of the state of a qubit through collective spin measurement via the Faraday interaction and magnetic field controls, and develop a maximum-likelihood estimate based on the Fisher information contained in the measurement record.

[1] A. Silberfarb and I. H. Deutsch, "Quantum-state reconstruction via continuous measurement," Phys. Rev. Lett. 95, 030402 (2005).

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