Bayesian parameter inference from continuously monitored quantum systems

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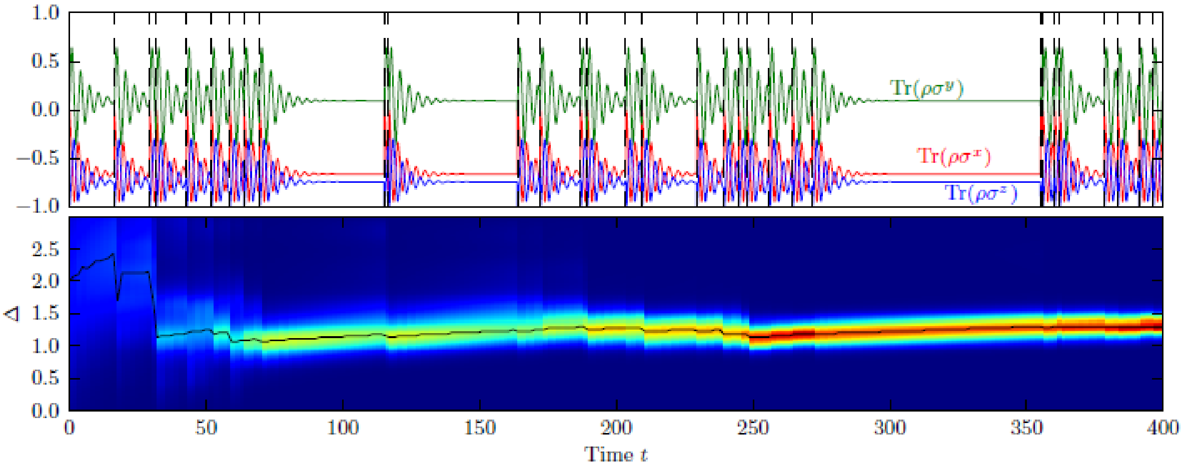
We show how likelihood functions and Fisher information from classical estimation theory can be defined in a very similar manner within quantum measurement theory.

We show that the stochastic master equations describing the dynamics of a quantum system subject to a definite set of measurements provides likelihood functions for unknown parameters in the system dynamics, and we show that the estimation error, given by the Fisher information, can be identified by stochastic master equation simulations.

For large parameter spaces we describe and illustrate the efficient use of Markov Chain Monte Carlo sampling of the likelihood function. These techniques can be used to accurately and efficiently analyse the result of experiments performed on quantum systems, where little data may be available.

References:

[1] Søren Gammelmark and Klaus Mølmer, *to appear in Phys. Rev. A (2013), arXiv:1212.5700 [quant-ph]*



Bayesian estimation of detuning, Δ, in a driven two-level atom while subject to detection of spontaneous emitted photons. (top) Time evolution of the two-level system conditional on a random detection record, (bottom) Bayesian estimation of detuning using the detection record from the top figure.