Abstract Submitted
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Optimal sensing at the nanoscale with diamond nitrogen vacancy center[1] WEN YANG, PING WANG, Beijing Computational Science Research Center — Diamond nitrogen-vacancy center is a leading platform for ultra-precise sensing at the nanoscale. The sensing is essentially a parameter estimation problem: (1) Encoding the unknown parameters into the NV state; (2) Readout the NV state from the fluorescence; (3) Process the data to infer the unknown parameters; (4) Adaptation of (1)-(3) based on the updated knowledge about the unknown parameters. Recently, dynamical decoupling and adaptive measurement have significantly improved the sensitivity and dynamic range by improving steps (1) and (4), respectively. However, a full optimization of all the steps remains lacking, e.g., the widely used approach to step (3) based on averaging the data from repeated fluorescence measurements or from single-shot fluorescence binarized into 0 and 1 is suboptimal. Here we apply quantum metrology techniques, developed in optical phase estimation, to construct a general framework for optimal sensing using the NV center, incorporating the finite detection efficiency and decoherence. It can be readily applied to various sensing tasks, such as dc/ac magnetometry, noise spectroscopy, and single-molecular NMR. For illustration, we demonstrate significant sensitivity improvement in tracking a time-varying magnetic field with the NV center.

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