Optimized emulation of quantum magnetometry via superconducting qubits

Sensing

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2023

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ABSTRACT

Quantum magnetometry based on adaptive phase estimation allows for Heisenberg precision, while avoiding creation and maintenance of complex entangled states. However, the absolute sensitivity is limited by the non-optimal use of quantum resources provided by multiple-qubit devices and algorithmic realisations of the protocol. Here, addressing both issues, we advance the time-ascending phase estimation protocol by numerical improvements of Bayesian learning, {} sequential updating of the field distribution, and optimal exploitation of resources provided by unentangled qubits with limited coherence. Such algorithmic improvements are used to evaluate the absolute sensitivity both on a simulator and by pulsed-transmon experiments conducted on the IBMQ platform, where we take advantage of high coherence time. { In addition, we compare proficiency of separable and entangled states for magnetometry and show that, in practice, separable states provide superior performance. Flux-sensing emulation experiments demonstrate that a sensitivity of **0.17–1.74μΦ0/√Hz** (where **Φ 0** is the flux quantum) for a single qubit and **0.06 – 0.65 μ Φ 0 / √ H z** for a five-qubit magnetometer can be achieved for slowly-oscillating **1 – 10 k H z** magnetic fields, which is comparable with more established experimental platforms for magnetometry.

The full article can be found here:
https://journals.aps.org/pra/accepted/b6076Nc9M931a02391e250f95a8210a67a36ff74e