Hamiltonian estimation in semiconductor spin qubits

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In this talk, I will present some progress we made in developing adaptive Bayesian techniques tailored for estimating slowly fluctuating Hamiltonian parameters. Taking the capabilities of state-of-the-art FPGA-based control hardware as a boundary condition, we explore strategies for efficient Hamiltonian estimation [1], including the potential use of on-chip neural networks and taking into account the physics of the fluctuating parameters. The simplified adaptive scheme we develop is memory efficient and can bring more than an order of magnitude improvement in estimation accuracy compared to the standard approach. We also made the first steps in using such Bayesian estimation protocols in experiment to track the slowly fluctuating Overhauser gradient in singlet-triplet spin qubits, showing indeed clear improvement in estimation quality when using adaptive and physics-informed methods [2,3].

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[3] F. Berritta, J. A. Krzywda, J. Benestad, J. van der Heijden, F. Fedele, S. Fallahi, G. C. Gardner, M. J. Manfra, E. van Nieuwenburg, J. Danon, A. Chatterjee, and F. Kuemmeth, Phys. Rev. Applied **22**, 014033 (2024).