Dynamic qubit stabilization with real-time noise surveillance

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A significant part of research in the field of quantum technologies is focused on mitigating noise, either by improving materials, developing noise decoupling schemes, or designing intrinsically noise-insensitive qubits. Here, we show an alternative approach in which the noise is continuously monitored and qubit control signals are adjusted accordingly [1]. We demonstrate such dynamic stabilization algorithms with semiconductor spin qubits, which have shown to be a promising platform for implementing quantum processors [2, 3] and now operate near the error-correctable threshold [4]. We use singlet-triplet qubits in GaAs double quantum dots [1]. Single shot qubit classification is performed in real-time on a dedicated quantum controller [5]. This pulse processor also enables, and greatly simplifies, the implementation of the on-the-fly Hamiltonian estimation protocol [6] with real-time feedback on the qubit control sequence. With one of this qubit's control axes entirely governed by noise, caused by the fluctuating Overhauser gradient, we will show how our protocol not only improves the qubit coherence but also enables the full two-axis and real-time control over the qubit, without requiring a micromagnet or nuclear polarization protocols.

References

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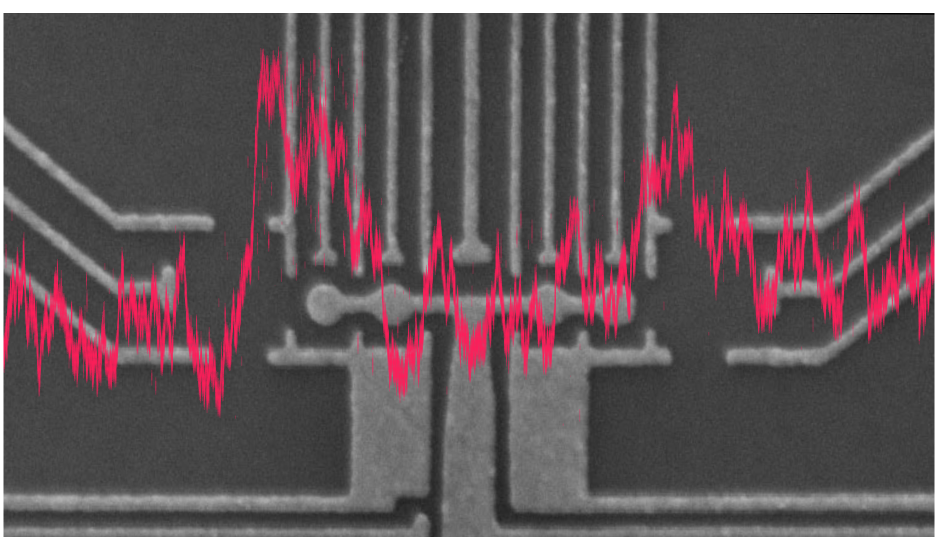

Fig. 1. Real-time Overhauser gradient estimation, displayed on an SEM image of the used singlet-triplet GaAs device [1].