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Error correction strategies for quantum sensing with ancillary qubits

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Quantum sensors exploit the strong sensitivity of quantum systems to external disturbances to measure various signals in their environment with high precision. However, the same strong coupling to the environment also limits their sensitivity due to its decohering effects. Error correction strategies, including quantum error correction codes and dynamical decoupling, can help in fighting decoherence, but they incur the risk of also canceling the coupling to the signal to be measured. Exploiting additional ancillary qubits enables novel strategies to achieve an advantageous compromise between noise and signal cancellation, thus improving the sensitivity of the quantum sensor. Additional qubit sensors could for example be used in quantum error correction codes or to stabilize the response of the main sensor qubits by detecting external perturbations. They could even be used as quantum lock-in amplifier to avoid the effects of low-frequency noise or as memory to improve the sensor readout. This suite of strategies shows the practical quantum advantage of small composite quantum sensing devices, even without the need to achieve the Heisenberg scaling in sensing.