Quantum Metrology of Pauli Channels

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Establishing the limits of precision in the estimation of parameters for noisy quantum channels probed by qubits is important for many areas of quantum information, like quantum sensing, computation, and communication. This talk considers the estimation of parameters characterizing a general class of noisy Pauli channels, which describe the possible errors that may affect a qubit. We show that two entangled qubits, such that only one of them probes the channel, may lead, under an entangling measurement, to strong enhancement of the precision in the estimation, as compared to the precision corresponding to sending the pair, entangled or not, through the channel. Entanglement plays an essential role, as does the entangling detection procedure, consisting in projecting the final state onto a Bell-state basis. Quantum advantage is obtained only when the output state, after interaction with the sample, is not entangled anymore. This behavior has striking similarities with quantum illumination, where initial entanglement of probe and ancilla beams, followed by an entangling measurement, lead to enhancement of the sensitivity of photodetection, even after the output beams are disentangled.