

Universal Protection of Quantum States From Decoherence

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One of the main challenges of quantum technologies is the mitigation of decoherence, i.e., the unavoidable coupling of quantum systems with the environment. One possible way to suppress decoherence is to exploit the Quantum Zeno Effect (QZE) [1,2]; however, QZE-based schemes require prior knowledge of the state to be protected is required [3-6].

Here we introduce a QZE-based scheme named Quantum State Universal Protection (QSUP), granting universal protection of arbitrary quantum states propagating through a decoherence-affected quantum channel [7]. We implement the QSUP protocol with polarization-encoded single-photon qubits passing through a free-space channel, testing the protocol for different qubit states and decoherence mechanisms (realized via birefringence).

Experimental results show that our protocol grants output qubit states showing close-to-1 Purity and Fidelity (w.r.t. the input ones) in all cases, dramatically increasing the robustness and reliability of the transmitted quantum information. The QSUP protocol is universally applicable, since it does not depend on the form of decoherence occurring within the quantum channel nor on the specific quantum state undergoing it, in contrast to state-dependent protection schemes or tailored quantum error-correction codes. As such, it provides a broadly applicable solution for quantum communication, distributed quantum sensing, and quantum computation.

References

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