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Quantum error correction of photon-scattering errors NITZAN AKERMAN, YINNON GLICKMAN, SHLOMI KOTLER, ROEE OZERI, Weizmann Institute of Science — Photon scattering by an atomic ground-state superposition is often considered as a source of decoherence. The same process also results in atom-photon entanglement which had been directly observed in various experiments using single atom, ion or a diamond nitrogen-vacancy center. Here we combine these two aspects to implement a quantum error correction protocol. We encode a qubit in the two Zeeman-splitted ground states of a single trapped $^{88}Sr^{+}$ ion. Photons are resonantly scattered on the $S_{1/2} \rightarrow P_{1/2}$ transition. We study the process of single photon scattering i.e. the excitation of the ion to the excited manifold followed by a spontaneous emission and decay. In the absence of any knowledge on the emitted photon, the ion-qubit coherence is lost. However the joined ion-photon system still maintains coherence. We show that while scattering events where spin population is preserved (Rayleigh scattering) do not affect coherence, spin-changing (Raman) scattering events result in coherent amplitude exchange between the two qubit states. By applying a unitary spin rotation that is dependent on the detected photon polarization we retrieve the ion-qubit initial state. We characterize this quantum error correction protocol by process tomography and demonstrate an ability to preserve ion-qubit coherence with high fidelity.

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