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Measurement, entanglement, and collapse, in atom-photon scattering ROEE OZERI, YINNON GLICKMAN, SHLOMI KOTLER, NITZAN AKERMAN, Weizmann Institute of Science — Photon scattering is a common tool in atomic physics experiments. We show how, entanglement, measurement and decoherence are intertwined in the process of photon scattering by a single trapped ion. We preform quantum process tomography on the spin of a single trapped $^{88}Sr^{+}$ ion, undergoing resonant photon scattering [1]. We observe that, following the scattering and detection of a single photon, a spin measurement basis emerges. The measurement basis is aligned with the scattered photon direction and its state are invariant under photon scattering. We also find that, while the measurement basis states themselves are classically correlated with the scattered photon polarization, superpositions of these basis state become entangled with the scattered photon. Quantum feedback, based on photon polarization measurement, can be used to reverse photon scattering decoherence [2].

[1] Y. Glickman, S. Kotler, N. Akerman, and R. Ozeri. "Emergence of a measurement basis in atom-photon scattering." arXiv e-prints, (2012). Science In Press.
[2] N. Akerman, S. Kotler, Y. Glickman, and R. Ozeri. "Reversal of photon-scattering errors in atomic qubits" Phys. Rev. Lett., 109:103601, (2012).

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