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Puzzle in decoherence measurements of entangled annihilation photons

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The annihilation photons are the first system where the entanglement of quantum states was experimentally studied. These photons are produced in the positron-electron annihilation and have 511 keV energy that coincides with the electron mass. According to the theory, two photons have mutually perpendicular linear polarizations, and their quantum states are entangled. Inspite of extensive studies the entanglement was not experimentally proved due to the low efficiency of Compton polarimeters that are the only tool for the polarization measurements of photons with such a high energy. We constructed the setup that allows a direct comparison of polarization correlations for both, entangled and decoherent quantum states. The natural expectation is observation of principal differences in behavior of these two different quantum states. Nevertheless, the experimental results reveal the same behavior in the polarization correlations of both, entangled and decoherent states. We discuss the construction of setup, Monte Carlo simulation and the experimental measurements of entangled and decoherent annihilation photons. A physical interpretation of the data is presented.

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