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Evolution of polarization correlations of annihilation photons during Compton scattering

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We present the final results of our experimental program on the evolution of polarization correlations of annihilation photons when one of the photons undergoes Compton scattering. The correlation measure of the photon pair is extracted from the measured visibility of azimuthal angular correlations by factoring out the analyzing power of the Compton polarimeters. In our previous work, the measurements covered forward scattering angles up to 35° and backscattering near 180° . In this work, we extend the range to include large-angle scattering, covering the full range of Compton scattering angles. The experimental results are compared with the analytical prediction based on quantum field theory and with the result of Monte Carlo simulations of classically correlated photons. All descriptions are found to be in agreement with the data over the full range of scattering angles. The behaviour of polarization correlations during scattering is identical to that of classical correlations up to a constant factor of two, which is consistent with local quantum field theory and does not require “spooky action at a distance.” These results confirm the latest theoretical predictions and resolve the “decoherence puzzle” reported earlier.

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