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Quantum Entanglement of Particles With Zero Lifetime in Photoproduction Process

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The Drell-Soding mechanism, which describes non-resonant pair production via linearly polarized virtual photons in ultra-peripheral heavy-ion collisions, arises from the coherent superposition of contributions from both colliding nuclei. The angular momentum of the system is imprinted in the orbital angular momentum of the produced pair, leading to quantum entanglement between the two particles. Since the produced particles cease to interact with each other after production, they can be treated as an Einstein-Podolsky-Rosen pair while simultaneously being considered as decaying particles with zero lifetime. In this work, we calculate the momentum modulation of Drell-Soding pairs induce by spin interference effects. These findings not only establish measurable signatures of entanglement in relativistic collisions but also offer new opportunities to test fundamental aspects of quantum electrodynamics and information transfer in high-energy environments, bridging the gap between quantum information science and particle physics phenomenology.

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