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Tunable hybrid and non-local entanglement in photon pairs

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Tailoring light's degrees of freedom and coupling them to enable complex transformations has become topical, with applications spanning high-dimensional information processing to advanced imaging systems at both classical and quantum levels. In this work, we introduce a voltage-controlled, multiwavelength spin-orbit coupling approach to engineer the entanglement properties of photon pairs generated via non-degenerate spontaneous parametric down-conversion. By adjusting the operational voltage, the device modulates its transformation rules, enabling a controlled transition from a configuration with non-local correlations across photons to one featuring local hybrid entanglement within a single photon. This versatile tool for structuring photonic states paves the way for interesting applications in quantum information processing.

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