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A Single-Photon Subtractor for Multimode Quantum States YOUNG-SIK RA, CLMENT JACQUARD, VALENTIN AVERCHENKO, JONATHAN ROSLUND, YIN CAI, ADRIEN DUFOUR, CLAUDE FABRE, NICOLAS TREPS, Laboratoire Kastler Brossel — In the last decade, single-photon subtraction has proved to be key operations in optical quantum information processing and quantum state engineering. Implementation of the photon subtraction has been based on linear optics and single-photon detection on single-mode resources. This technique, however, becomes unsuitable with multimode resources such as spectrally multimode squeezed states or continuous variables cluster states. We implement a single-photon subtractor for such multimode resources based on sum-frequency generation and single-photon detection. An input multimode quantum state interacts with a bright control beam whose spectrum has been engineered through ultrafast pulse-shaping. The multimode quantum state resulting from the single-photon subtractor is analyzed with multimode homodyne detection whose local oscillator spectrum is independently engineered. We characterize the single-photon subtractor via coherent-state quantum process tomography, which provides its mode-selectivity and subtraction modes. The ability to simultaneously control the state engineering and its detection ensures both flexibility and scalability in the production of highly entangled non-Gaussian quantum states.

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