Highlights

Light-matter interaction and non-equilibrium dynamics in advanced materials and devices - 2019

Continuous-variable entangled states of light carrying orbital angular momentum

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The orbital angular momentum of light, unlike spin, is an infinite-dimensional discrete variable and may hence offer enhanced performances for encoding, transmitting, and processing quantum information. Hitherto, this degree of freedom of light has been studied mainly in the context of quantum states with definite number of photons. On the other hand, field-quadrature continuous-variable quantum states of light allow implementing many important quantum protocols not accessible with photon-number states. Here, we realize a scheme based on a q-plate device for endowing a bipartite continuous-variable Gaussian entangled state with nonzero orbital angular momentum. We then apply a reconfigurable homodyne detector working directly with such nonzero orbital angular momentum modes in order to retrieve experimentally their entire quantum-state covariance matrix, thus providing a full characterization of their quantum fluctuation properties. Our work is a step towards generating multipartite continuous-variable entanglement in a single optical beam.

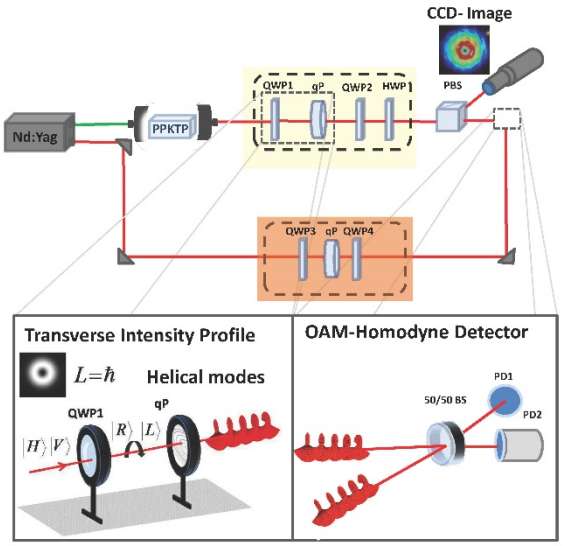

Fig. 1: Schematic of the experimental set-up. An optical parametric Oscillator generates a pair of orthogonally-polarized entangled modes. The yellow area shows the optical set-up for manipulating the polarization and Orbital Angular Momentum (OAM) d.o.f. of the beams. A similar set-up is placed along the Local Oscillator path for OAM homodyning (dark orange). The bottom-right inset shows the

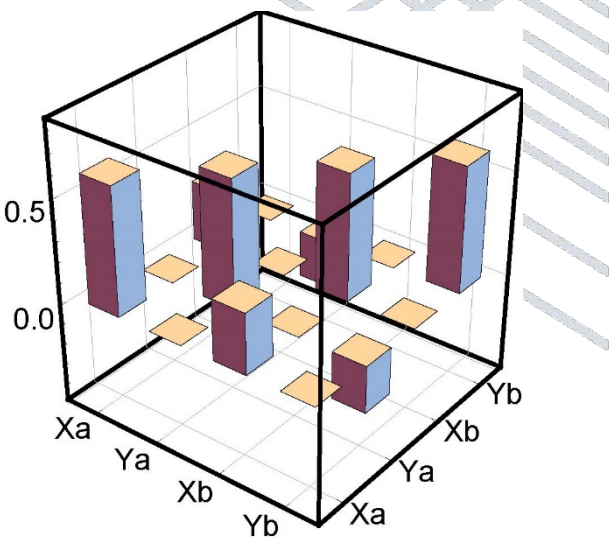

Fig. 2: Graphic representation of the measured covariance matrix of the entangled OAM state.
The non-zero elements outside the main diagonal are a signature of quantum correlation between pairs of quadratures of modes carrying different OAM.