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Tesis: "SPATIALLY ENCODED QUANTUM STATE FOR APPLICATION IN QUANTUM INFORMATION"

Resumen:

The spatial structure of light as a degree of freedom holds great potential for encoding large amounts of information in both classical and quantum optical communication systems. Spatial modes such as Hermite Gauss, or Laguerre Gauss modes are embedded in an infinite dimensional Hilbert space, a feature that can significantly enhance quantum information processing protocols. In particular, Laguerre Gauss modes, which are associated with discrete value of orbital angular momentum (OAM), have enabled numerous experimental demonstrations of high-dimensional quantum protocols that exhibit key advantages such as improved noise-tolerance or channel capacity in comparison to two-dimensional qubit state encoding. Quantum states exhibiting orbital momentum entanglement can be generated via spontaneous parametric down conversion (SPDC) in a nonlinear crystal as a consequence of momentum conservation during the process. This thesis we investigate a two-photon state in space and frequency using a Gaussian pump beam, for SPDC bulk in non-linear crystals, considering a collinear geometry, and restricting the spectral bandwidth to the narrowband case. We derive analytic expressions for two- and single photons spectral brightness. We also investigate the role of focusing parameters. As well as the optimal waist for the pump and the collection modes. A solution for the pair collection efficiency was previously derived. However, an analytical expression for the single photon collection has not been (to the best of our knowledge) reported, in order to verify that our results are correct, we calculate the heralding efficiency (given by the ratio of pair collection detection and the detection of a single photon) and compare our results with the one reported. For both (pair- and single-photon) collection probabilities our findings are in excellent agreement with the previous studies. The results obtained in this work are expected to be useful for designing SPDC sources with high performance in multiple categories.