Two-photon spectral amplitude resolved in separable Schmidt modes

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The ability to access high dimensionality in Hilbert spaces [1] represents a demanding keystone for state-of-art quantum information. The manipulation of entangled states in continuous variables, wavevector as well frequency, represents a powerful resource in this sense. The number of dimensions of the Hilbert space that can be used in practical information protocols can be determined by the number of Schmidt modes that is possible to address separately [2]. For wavevector variables it is possible losslessly filter Schmidt modes using single-mode fibre and a spatial light modulator [3] but no similar procedure exists for the frequency space. Aim of this work is to present a method of engineering spectral property of biphoton light, emitted via ultrafast spontaneous parametric down conversion, in such a way that the Two-Photon Spectral Amplitude (TPSA), that fully characterizes a biphoton sate [4], contains several non-overlapping Schmidt modes, each of which can be filtered losslessly in frequency variables. Such TPSA manipulation is operated by a fine balancing of parameters like the pump frequency, the shaping of pump pulse spectrum, the dispersion dependence of SPDC crystals as well as their length. Measurements have been performed exploiting the group velocity dispersion induced by the passage of optical fields through dispersive media [5], operating a frequency to time two dimensional Fourier transform of the TPSA [6]. Exploiting this kind of measurement we experimentally demonstrate the ability to control the Schmidt modes structure in TPSA manipulating the pump spectrum.

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