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Quantum-optical description of sum-frequency generation in terms of spatial light modes

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Nonlinear optical processes can offer exciting applications in quantum schemes, e.g., spontaneous parametric down-conversion is used as a source of entangled photons. However, most nonlinear optical processes are only considered classically and lack the required theoretical framework to describe what occurs on the quantum level.

Previously, a quantum derivation of difference-frequency generation was presented. Now a similar method is applied to sum-frequency generation, which thus completes the quantum optical description of second-order nonlinear processes in terms of spatial light modes. In particular, this demonstrates that on the quantum level, the output mode of sum-frequency generation is given by the product of the input modes, as predicted by classical optics. This is done for single photons as well as for coherent states. The change of amplitudes of input and output light as a function of the propagation length is calculated using elliptic functions.

Apply to be considered for a student ; award (Yes / No)?

Yes

Level for award;(Hons, MSc, PhD, N/A)?

PhD

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