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Wigner functionals in Quantum optics

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We study the spatiotemporal and particle number degrees of freedom of light in the framework of a new quantum optical formalism based on a generalised quadrature basis [1, 2]. This is an orthogonal complete basis for all quantum optical states. It gives rise to a description in terms of Wigner functionals that can incorporate all spatiotemporal degrees of freedom without approximations nor truncations of the number of light modes. Therefore, this formalism allows to calculate non-linear optical effects taking into account all experimental parameters, for example the size of apertures, input modes, the spectrum of the pump beams, etc. We focus on the non-linear effect of spontaneous parametric down conversion (SPDC) with its description in terms of the formalism of Wigner functionals [3]. A derivation of the kernel differential equations which arise from the evolution equation for the Wigner functional of the down-converted fields in the semiclassical approximation is shown. The derivation for the solution for this differential equation, which turns out to be the Magnus expansion, is also shown, along with the Wigner functional for a few operators.

References
[1] Filippus S. Roux and Nicolas Fabre. Wigner functional theory for quantum optics, 2020. arXiv:1901.07782.
[2] Filippus S. Roux. Combining spatiotemporal and particle-number degrees of freedom. Physical Review A, 98(4), Oct 2018. URL: http://dx.doi.org/10.1103/PhysRevA.98.043841, doi:10.1103/physreva.98.043841.
[3] Filippus S. Roux. Parametric down-conversion beyond the semi-classical approximation. Physical Review Research, 2(3), Sep 2020. URL: http://dx.doi.org/10.1103/PhysRevResearch.2.033398, doi: 10.1103/physrevresearch.2.033398.

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Yes

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

PhD

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