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Title: Stochastic methodology for superfluorescence

Place: Seminar room 915

Stochastic methodology for superfluorescence

As highlighted in [1], "... the problem of superradiance in free space is, in general, a problem of three-dimensional non-linear diffraction theory, further complicated by the quantum nature of the radiated field at the early stage of the emission process..." Due to the acknowledged complexity of the problem, the theoretical work within this field is typically focused on a specific aspect of this collective emission phenomenon. Our goal is to develop a general formalism grounded on rigorous derivations and suitable for the characterization of superfluorescence in distributed systems of atoms experiencing various incoherent processes such as dephasing, pumping, and Auger decay. The novel framework builds a solid foundation for quantitatively predictive investigations of light-matter interaction in realistic conditions.

The formalism is based on the positive P representation [2]. The resulting equations are convenient for numerical analysis and possess an intuitive structure. For instance, light-matter interaction with all subtle quantum effects requires equations similar to the Maxwell-Bloch ones. The only difference is that they include noise terms as a source. In the case of superfluorescence, these noise terms can be interpreted as the initial spontaneous emission triggering the process.

This methodology has been successfully applied to x-ray superfluorescence in various conditions [3,4]. In my talk, I will present the formalism and apply it to superfluorescence in compact and distributed systems in paraxial geometry. Besides, I would like to demonstrate our attempts to extend the formalism to quantum systems in cavities.

References

[1] Gross, M., & Haroche, S. (1982). Superradiance: An essay on the theory of collective spontaneous emission. Physics Reports, 93(5), 301–396.
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[3] A. Benediktovitch, S. Chuchurka, A. Halavanau, Krusic, and N. Rohringer, Stochastic modeling of paraxial x-ray Superfluorescence, ArXiv (2023).
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