Practical Quantum Optics

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This short course aims at giving an introduction to quantum optics using phenomenological approaches and visualizing the field from the viewpoint of a practitioner. There are altogether five parts:

(1) pointing out a close link between Maxwell's equations and the properties of the quantum vacuum with its virtual particle anti-particle pairs [1,2];
(2) introduction to field quantization from an experimental perspective using the intuition of a classical optical scientist;
(3) answering the question "What does it mean if optics is quantum? What distinguishes quantum from classical? [3,5]
(4) description of quantum optical experiments with discrete and with continuous variables with special emphasis on Wigner functions in phase space and the special role of the quantum measurement process [4];
(5) In this fifth part we address the question: "Is hard core quantum optics solely concerned with the study of fundamental physics questions or is it also useful for practical applications? From laser interferometric gravitational wave detection to quantum distribution of cryptographic keys and quantum information processing [6-8].

The course will discuss quantum aspects in optics using phenomenological approaches whenever possible and mathematical description whenever necessary. The generation, propagation and detection of quantum light is one central topic. Practical quantum optics is all about noise, noise reduction and overcoming established sensitivity limits in interferometry, imaging, communication, information processing and sensing. Emphasis is put on practical considerations. Possible limits and opportunities that quantum effects may impose on applications in industry in the foreseeable future will be discussed. One of these opportunities is quantum computing with photonics, which is currently attracting much attention.

The course is designed to appeal to an audience without prior experience in quantum optics as well as to researchers who want to refresh and be updated with current trends.,

References

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