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Fakultät für Naturwissenschaften, Fachbereich Physik

Announcement

Optical and Quantum Metrology

Dr. Enno Giese, Dr. Sabine Wölk

Description

Optical devices have long been proven to be a powerful tool for metrology; and interferometers are amongst the oldest high-precision instruments in physics. Their supreme sensitivity is for example underlined by the direct observation of gravitational waves. To enhance their sensitivity even further, a novel generation of gravitational wave detectors will rely on quantum features of light that will allow for an operation beyond the shot-noise limit. The lecture “optical and quantum metrology” aims to teach the fundamental working principles and concepts of such devices.

As such, this theoretical lecture gives a basic understanding of optical and quantum metrology. We discuss the estimation of parameters in general terms and through specific measurement schemes, not solely focusing on optical approaches. The lecture covers linear and nonlinear optical devices seen from a quantum perspective and links entanglement or correlations to quantum imaging. Different features of quantum mechanical states of light and their effect on interferometry play a central role for the syllabus. Including nonlinear elements into interferometers allows for a combination of the generation of quantum states with the scheme itself. The methods and concepts taught in the course can be also transferred to other fields of quantum sensing so that the scope of the lecture is beyond optical quantum metrology.

Prerequisites

Optics and electrodynamics, quantum mechanics

Literature

- G. Grynberg, A. Aspect and C. Fabre, "Introduction to Quantum Optics: From the Semi-classical Approach to Quantized Light" (Cambridge University Press, 2010)
- M. Suda, "Quantum Interferometry in Phase Space: Theory and Applications" (Springer, 2006)
- W. P. Schleich, "Quantum Optics in Phase Space" (VCH-Wiley, 2001)
- C. C. Gerry and P. L. Knight, "Introductory Quantum Optics" (Cambridge UniversityPress, 2005)
- D. S. Simon, G. Jaeger and A. V. Sergienko, "Quantum Metrology, Imaging, and Communication" (Springer, 2017)

Additional information

Lecture (3 hours per week) with exercises (2 hours per week)
Examination: orally or written
6 ECTS credits

Lecturers

Dr. Enno Giese (Institute of Quantum Physics), Dr. Sabine Wölk (DLR Institute QT)