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Fakultät für Naturwissenschaften, Fachbereich Physik

Announcement

Theoretical Quantum Optics

Dr Felipe Caycedo-Soler

Description

The field of quantum optics has served as an important tool to measure and verify the principles of quantum mechanics. This lecture, besides providing an adequate historical context of some of the main developments, it emphasizes the interplay between the theoretical concepts and the experimental achievements that have given shape to the current understanding in this field. This course should be useful for graduate students in physics as well as for research workers who want to become familiar with the ideas of quantum optics.

Content

		Loudon Scully Garrison Gerry
1	Preliminaries: Ultraviolet catastrophe, Plank's Law, Einstein coefficients	1.1-1.4 , 1.1.1 ,1.5-1.7
2	Semiclassical atom-radiation interaction	
2.1	Microscopics of Einstein coefficients, semi-classical Rabi model	2.1-2.3,2.5; 4.4
2.2	Doppler Broadening and inhomogeneous broadening	2.6
2.3	Empirical approach to homogeneous broadening	2.5, until 2.5.8 or 2.5.21
2.4	Density operator and optical Bloch equations	2.7.1-2.7.3
3	The quantum nature of light	
3.1	Preliminaries: Are photons needed? Planck's dist. Compton scattering and photoelectric effect. Photo-indivisibility	1.3-1.5
3.2	Field quantization, Fock states, quantum fluctuations, quadratures, multimodes and thermal field	2.1-2.5
3.3	Vacuum fluctuations: Lamb shift (and Casimir effect)	2.6, 1.3, 1.5
3.4	Coherent and Squeezed states	2.1-2.6
3.5	Phase space distributions and characteristic functions P, Q and Wigner-Weil	3.1-3.5, 3.7-3.8
4	Quantum mechanical atom-field interaction	
4.1	Interaction of an atom with a quantized field, Jaynes-cummings model	6.1-6.2, 4.5
4.2	Density operator II, General reservoir theory and atomic decay	8.1-8.2
4.3	Driving an atom by a laser: the quantum jump approach	Ref.1 and 8.5
5	Resonance fluorescence and photon-photon correlation functions	
5.1	Photodetection excitation probabilities, single and two photon	9.1.2, 9.2.4, 6.5

5.2	Electric field operator in the far zone approximation	10.A
5.3	Theory of spectrum analyzer	10.3
5.4	Onsager-Lax regression theorem and the complete resonance fluorescence spectrum	10.4-10.5
5.5	First and Second-order coherence of the fields	3.1, 3.3-3.5, 3.7-3.8
5.6	Photon anti-bunching	10.6

Literature

- R. Loudon, The *Quantum thoery of light* (Oxford University Press, New York, 2000)
- M.O. Scully and M.S. Zubairy, *Quantum Optics* (Cambridge University Press, Cambridge, 1997)
- G.C. Garrison and R. Y. Chiao, *Quantum Optics* (Cambridge University Press, Cambridge, 1997)
- C.C. Gerry and P.L. Knight, *Introductory Quantum Optics* (Oxford University Press, New York, 2008)

[1] J. Dalibard, Y. Castin and K. Mölmer,, Phys. Rev. Lett., 68, 580 (1992),

Prerequisites

A basic knowledge of quantum mechanics, electrodynamics and classical statistics is assumed.

Details

Lectures (3 SWS), exercises (2 SWS), 6 ECTS credits

Lecturer

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