



Quantum Optics

Outline:

1. Brief Review of Quantum Physics

- a) Mathematical Background: Linear Algebra
- b) Classical Mechanics
- c) Postulates of Quantum Mechanics
- d) Quantum Statistics
- e) The harmonic oscillator
- d) The two-level atom

2. Quantum Theory of light

- a) Brief review of electromagnetic theory. Cavity Modes
- b) Quantization of EM fields. Photons
- c) States of EM radiation. Coherent and thermal states
- d) Photon statistics Photon bunching and antibunching. Squeezed states

3. Interaction of Light with Matter.

- a) Spontaneous and stimulated transitions
- b) Theory of photon detection. Photoelectron statistics
- c) Quantum theory of laser

4. Coherent Interaction of Light with Two-Level Atoms

- a) General theory
- b) Super-radiance
- c) Photon echo
- d) Self-induced transparency

5. Parametric Interactions in Nonlinear Optics

- a) Three-wave mixing
- b) Four-wave mixing effects. Phase conjugation
- c) Generation of entangled-photon states
- d) Elementary quantum information processing: entanglement swapping and quantum teleportation
- e) Elements of quantum optical computing

TEXTBOOK: Class Notes and
Optical Coherence & Quantum Optics, Mandel and Wolf (recommended)

Boston University

Department of Electrical and Computer Engineering

INSTRUCTOR: Alexander Sergienko Office: PHO 729 Phone: 3-6564
e-mail: alexserg@bu.edu

SCHEDULE: Monday-Wednesday 12-2 PM SOC B67

Quantum Optics

Selected Reference Books

L. Mandel and E. Wolf, *Optical Coherence and Quantum Optics*, Cambridge University Press, Cambridge, 1995

W. H. Louisell, *Quantum Statistical Properties of Radiation*, Wiley, 1973

R. Loudon, *The Quantum Theory of Light*, Oxford, second edition, 1979

A. Yary, *Quantum electronics*, 3Rt edition, Wiley, 1989

W. H. Louisell, *Radiation and Noise in quantum Electronics*, McGraw-Hall, 1964

M. O. Scully and M. S. Zubairy, *Quantum Optics*, Cambridge, 1997

S. M. Barnett and P. M. Radmore, *Methods in Theoretical Quantum Optics*, Oxford, 1997

W. Vogel and D. Welsch, *Lectures on Quantum Optics*, Akademie Verlag, 1994

D. N. Klyshko, *Photons and Nonlinear Optics*, Gordon and Breach, New York, 1988.

H. A. Bachor, *A guide to Experiments in Quantum Optics*, Wiley- VCH, 1998

J. R. Klauder and E. C. G. Sudarshan, *Principles and Fundamentals of Quantum Optics*, Benjamin, 1968

W. E. Lamb, M. Sargent, and M. O. Scully, *Laser Physics*, Addison-Wesley, 1974

B. E. A. Saleh, *Photoelectron Statistics*, Springer-Verlag, Berlin, 1978

D. Bouwmeester, A.K. Ekert, A. Zeilinger, *The Physics of Quantum Information* Springer-Verlag, Berlin, 2000.

Alexander V. Sergienko ed. "Quantum Communications and Cryptography", CRC Press, Taylor & Francis Group, New York, ISBN 0-8483-3684-8, (2006).