Boston University
Department of Electrical and Computer Engineering

Fall 2011 EC 762

Quantum Optics

Outline:

Part I: Introduction to quantum optics, quantum information and communication

Topics:

1. Lecture 1-2: Review of Quantum Mechanics;
2. Lecture 3-4: quantization of EM field;
3. Lecture 5-6: statistics of radiation;
4. Lecture 7:entanglement;
5. Lecture 8-9: quantum interferometry;
6. Lecture 10-11: principles of quantum key distribution and quantum computation.

Part II: quantum measurement, imaging, and metrology

Topics:

1. Lecture 12-13: Generation and detection of entangled states;
2. Lecture 14: linear-optical quantum state engineering;
3. Lecture 15-16: high-resolution quantum interferometry;
4. Lecture 17-18: entangled and correlated quantum imaging;
5. Lecture 19-20: cancellation of dispersion and aberration in biological optical imaging.
6. Lecture 21-22: Project presentations.

TEXTBOOK: Class Notes and
C. Gerry, P. Knight, "Introductory Quantum Optics", (Cambridge 2005)
G. S. Jaeger, "Quantum Information: An Overview", Springer (2010).

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SCHEDULE: Monday-Wednesday 12-2 PM PHY B36

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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. Yariv, *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).

Optical Coherence and Quantum Optics, by Mandel and Wolf. The details, in detail. This one you need to sit down and study. I think it's rather complete, and as rigorous as a physicist gets. As an experimentalist, I learned an awful lot from this book, and gained much deeper understanding of things.Â If you are interested in statistical properties of quantum optics then the best book is Quantum statistical properties of radiation, by W. H. Louisell. This is easy and very much reader friendly. Since my PhD work based on partly quantum optics I have personally used this book. Almost all the derivation are done in the book.Â Making statements based on opinion; back them up with references or personal experience. Use MathJax to format equations. MathJax reference. Quantum optics rst entered the business of quantum information processing with the proposal of Cirac and Zoller in 1995 to use ion trap technology. Fol-lowing pioneering work by Dehmelt and others using ion traps for high resolu-tion spectroscopy, by the early 1990s it was possible to trap and cool a single ion to almost the ground state of its vibrational motion.Â Quantum computation requires the ability to strongly entangle independent de-grees of freedom that are used to encode information, known as qubits. It was ini-tially thought however that the very weak optical nonlinearities typically found in quantum optics would not be powerful enough to implement such entangling opera-tions.