

Course Objectives:

This course is for PhD and advanced undergraduate students who want to gain a solid understanding of the concept of coherence as well as its applications in modern quantum optics. The course will have two main parts. The first part, which will cover about 1/3rd of the course, will discuss the concept of coherence; the remaining part of the course will focus on Quantum Entanglement.

Course content:

- (1) **Coherence:** Spectral properties of stationary random processes, Wiener-Khintchine theory, Angular spectrum representation of wavefields, Introduction to the second-order coherence theory, Propagation of coherence, The van Cittert-Zernike theorem, Coherent mode representation of sources and fields.
- (2) **Quantum Entanglement:** Basics of nonlinear optics, Two-photon field produced by parametric down-conversion, EPR paradox, Bell inequalities and its experimental violations, Quantum theory of higher-order correlations, Two-photon coherence and two-photon interference effects. Two-photon entanglement in the following variables: time-energy, position-momentum, and angle-orbital angular momentum; Introduction to Quantum Information: Quantum Cryptography, Quantum Dense Coding, Quantum Teleportation, Quantum Imaging.
- (3) **Additional topics** (may be covered during the course or given out as small projects): Photoelectric detection of light, The Hanbury Brown-Twiss experiment, Photon-bunching and antibunching, Photon Statistics, Squeezed states of light.

Instructor:

Anand Kumar Jha; Office: Faculty Building 351; Lab: CL 104 D

Ph: (+91)512-259-7014(Off); (+91)962-142-3993(Mobile) Email: akjha@iitk.ac.in ; akjha9@gmail.com

Course Webpage: <http://home.iitk.ac.in/~akjha/PHY690G.htm>

Lecture: Mondays & Thursdays: 9:00 am – 10:15 am in T-105

Office Hour: There will be no scheduled office hour. You could see me in my office/lab with questions/concerns as and when I am available there. Alternatively, you could email/phone me to setup a meeting time.

Evaluation: 20% Homework (5/6 homeworks); 30% Mid-sem exam or project; 50% End-sem exam.

Reference books:

1. L. Mandel and E. Wolf, *Optical Coherence and Quantum Optics* (Cambridge university press, New York, 1995).
2. R. W. Boyd, *Nonlinear Optics*, 3rd ed. (Academic Press, New York, 2008).
3. J. W. Goodman, *Statistical Optics*, (John Wiley and Sons, 2000)
4. R. Loudon, *The Quantum Theory of Light*, 3rd ed. (Oxford University Press, New York, USA, 2000).
5. M. Born and E. Wolf, *Principles of Optics*, 7th expanded ed. (Cambridge University Press, Cambridge, 1999).