## Course Title: Coherence and Quantum Entanglement
## Course Number: PHY690 G;    Semester-I, 2017-18

**Instructor:**

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**Course content:**

This course will have two main parts. The first part, which will cover about 1/3$^{rd}$ of the course, will discuss the concept of coherence; the remaining part of the course will focus on Quantum Entanglement.

(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.

**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).

**Evaluation:**

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