PHY 681 - Quantum Field Theory

2021-22-I Semester;

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- **Aim:** This will be an introductory course on Quantum Field Theory (QFT) aimed at Advanced Master's level and beginning PhD students.
- **Pre-requisite:**
  - Lagrangian and Hamiltonian formulation of classical mechanics,
  - Special theory of relativity (in 4-vector notation),
  - Classical Electrodynamics (in 4-vector notation),
  - Advanced quantum mechanics at the level of the course *"Quantum Mechanics II (PHY432)"* (for existing IITK students). Familiarity with Relativistic Quantum Mechanics (e.g. Klein Gordon equation, Dirac equation etc.) will be useful.
  - Mathematical Methods: Complex Analysis, Fourier Transformations
- **Plan of the course:** The following topics will be covered in the course:
  1. *Elements of classical field theories:* Lagrangian formulation; Lorentz invariance; symmetries, Noether's theorem and conserved currents.
  2. *Quantum field theory with scalar fields:* (a) Free scalar fields: Klein-Gordon equation, canonical quantization, propagators. (b) Interacting scalar fields: Wick's theorem, Feynman rules.
  3. *Quantum field theory with fermionic fields:* Spinors in Lorentz group, Dirac equation, canonical quantization.
  4. *Quantum field theory with gauge fields:* Gauge symmetries, quantum electrodynamics (QED), canonical quantization, working with Feynman diagrams, studying QED processes.
  5. *Other topics (if time permits):* The method of second quantization for many-body quantum systems, divergences in Feynman diagrams and few other possible topics.