Quantum Field Theory II–Spring 2011

Ling-Fong Li

This course is a continuation of Quantum Field Theory course I given last semester. It will include the following topics:

Part III. Symmetry

1) Group Theory
    a. Representation theory
    b. SU(2) and rotation group
2) Global symmetry
    a. Conservation laws
    b. Symmetry and renormalization

3) Local symmetry
    a. Abelian gauge symmetry
    b. Non-abelian symmetry
4) Spontaneous symmetry breaking
    a) Goldstone theorem
    b) Higgs phenomena

Part IV. Standard Model of Electroweak Interaction

1) Construction of SU(2) X U(1) theory
    a) Weak interaction before gauge theory
    b) Choice of the group and tree unitarity
    c) Gauge theory with leptons
    d) Quarks masses and mixing
2) Phenomenology of Standard Model
    a) Neutral current reactions
    b) W and Z gauge bosons
    c) Neutrino oscillations
    d) Higgs particle

Part V. Theory of Strong Interaction--Quantum Chromodynamics

1) Structure of Proton—electron proton scattering
    a) Rutherford formula
    b) Mott formula
    c) Rosenbluth formula and form factors
2) Deep Inelastic lepton nucleon scattering
        a) Deep inelastic ep and neutrino scattering
        b) Bjorken scaling
        c) Parton model
3) Light-cone singularities
    a) Light-cone singularities and Bjorken Scaling
    b) Product of currents and short distance expansion
    c) Free field singularities and scaling
    d) Light-cone singularities and deep inelastic scattering
4) Quantization of gauge theories
        a) Isolating volume factor in Path Integral
        b) Volume factor in gauge theory-Faddeev-Popov ansatz
        c) Covariant gauge
5) QCD
        a) Quark Model and color symmetry
        b) Asymptotic freedom and Non-Abelian theory
        c) QCD Lagrangian
        d) Renormalization group analysis of scaling and scaling violation
        e) Quarkonium

Part VI. Grand unification

        a. SU(5) model
        b. Proton decay
        c. Baryon number asymmetry

References:

1) T. P Cheng and L. F. Li, “Gauge Theory of Elementary Particle Physics”, Oxford University Press (1984).
2) M. Peskin and D. Schroeder, “An Introduction to Field Theory”, Addison-Wesley (1995).
3) S. Weinberg, “Quantum Field Theory” Volume 1, (Cambridge University Press) (1995).
4) M. Srednicki, “Quantum Field Theory”, (Cambridge University Press) (2007).