ICTP DIPLOMA PROGRAMME IN HIGH ENERGY PHYSICS 2014-15

SYLLABUS

Quantum Electrodynamics- {21 Lectures = 31.5 hours} G. Villadoro

-Classical Field Theory
Poincar√© Transformation properties of Fields
Least Action Principle
Equations of Motion
Hamiltonian Density
Solutions of free equations of motion and with external sources
Green Functions

-Noether Theorem
Conserved Currents
Energy Momentum Tensor
Angular Momentum Tensor
-Quantum Field Theory for free Spin-0 Fields
Microcausality and Commutation Relations
Quantization of Klein Gordon Equations
Creation and Annihilation operators and algebra
Hamiltonian and Momentum operators
Vacuum state, particles and Fock space
Boson Statistics from QFT
Poincar√© Transformations in QFT
Complex Scalar Fields
Normal Ordering
Time Ordering
2- and n- point functions

-Quantization of Spin-1/2 Fields
Spinorial Representation of the Lorentz Group
Fermi-Dirac and Weyl representation of spinors
Dirac Equation and solutions
Quantization of Spin-1/2 Fields
Anticommutation Relation and Causality
Fermi Statistics
Spin and Helicity Operators
2- and n- point functions
Conserved current and Charge
C, P (and T) symmetries

-Quantization of Spin-1 fields
Physical polarization
Gauge redundancy and Lorentz invariance
Gauge invariant Lagrangian and Gauge Fixing
Quantization of Massless Spin-1 fields, physical and unphysical polarizations
Spin-1 propagator and physical interpretation
Coupling to other fields, Gauge invariance and Covariant Derivatives

-Interactions
  Interacting Lagrangian and particle non-conservation
  Scattering Amplitudes and S-Matrix
  Optical Theorem
  Dyson Series and perturbation theory
  Wick Theorem, Feynman Rules and Diagrams
  QED to first and second order
  Cross Section: 2 to n
  Unstable Particles: Decay rates
  Phase Space integrals
-QED at tree level
  e+e- -> mu+mu- cross section: polarized and unpolarized
  Compton Scattering: unpolarized
-Introduction to Effective Field Theories
  Relevant, Marginal and Irrelevant Interactions
  Low Energy Limit and decoupling of Heavy Particles
  Examples: Euler-Heisenberg Lagrangian and Reyleigh scattering