ICTP DIPLOMA PROGRAMME IN HIGH ENERGY PHYSICS 2013-14

SYLLABUS

Introduction to Particle Physics - {24 Lectures = 36 hours} A. Smirnov

I. Introduction

Defining elementary particles
Units and scales
Observations of elementary particles.

II. Discoveries of particles. Main concepts

1. Early discoveries

Electron, proton, neutron, photon.
Neutrino. Fermi theory of the weak interactions.

2. Detection of particles

Principles of detection of particles.
Radiation and ionization.
Scintillations and Cherenkov radiation

3. Cosmic rays and discoveries of particles

Cosmic rays.
Positron.
Muon.
Pion. Pion decay
Strange particles. Kaons. Strangeness

4. Acceleration of particles

Linear accelerators.
Cyclic accelerators.
First accelerator experiments. Muon neutrino.
LEP, Tevatron, LHC.

5. Quarks

Classification of hadrons.
SU(3)-symmetry. Eightfold way.
u, d and s quarks.
Introduction of color.
Quark jets.
Cross-section of the electron - positron annihilation to hadrons.
Cabibbo mixing.

6. Deep inelastic scattering

Form factors.
Structure functions.
Scaling. Partons.
Violation of scaling.

7. Heavy leptons and quarks

Observations of resonances.
Charmed particles. Discovery of J/ psi.
tau-lepton.
CKM-mixing.
Bottom quark.
Top quark.
Tau neutrino.

8. Discoveries of the gauge bosons and Higgs boson

Intermediate bosons W, Z.
Gluons.
Higgs boson.

9. Resonances.

Evolution matrix and S-matrix.
Optical theorem.
Total decay rate and total cross-section.
Resonances.

III. Symmetries and Interactions

1. Symmetries at classical and quantum level

Symmetries and transformations.
Conservation laws.
Properties of matrix elements.

2. Parity

P-transformations.
Parity conservation.
Parity of pion and other particles.
Parity violation.

3. Charge conjugation.

C-transformation.
C-parity.
Violation of C-symmetry.

4. CP-violation.

CP- properties of neutral K mesons.
Discovery of CP - violation.
Direct CP - violation.
CP - violation in B-meson system.

5. U(1) - symmetries

Baryon number.
Lepton number. Neutrinoless double beta decay
Individual leptonic numbers.
Neutrino oscillations.
MSW – effect.
B-L quantum number.

6. SU(2)-symmetry.

Isospin
Isospin symmetry in nucleon-nucleon scattering.
Isospin symmetry in pion-nucleon scattering.
Isospin and electric charge. Hypercharge.
G-parity.

References

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B. R. Martin and G. Shaw, ``Particle physics", Wiley 1997.

G. Kane, ``Modern elementary particle physics", Addison Wesley, 1993.

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