Y3 Particle Physics: 2012_13 Dr. N.K.Watson

Course Content

This is a non-exclusive summary of the material covered during the course. Please do not take this to mean it is *all* that you need to know – reading around the subject in textbooks (or on reliable web pages) is always encouraged and advantageous. "Reliable" here means either in a "peer-reviewed" scientific journal, or in major scientific conference. Please refer to handouts and information distributed as part of the course, in addition to notes taken during lectures. Information placed on the web after each lecture will replace that from the previous year on a rolling basis.

1. Relativistic Kinematics
    a. $(4\text{-momentum})^2$ invariance, invariant mass
    b. Hypothesis testing, production thresholds
    c. Cross sections, flux and luminosity
    d. Particle lifetime, decay length, width
2. Classification of particles
    a. Fermions and bosons
    b. Leptons, hadrons, quarks
    c. Mesons, baryons
3. Quark Model
    a. Meson and baryon multiplets
    b. Isospin, strangeness, c, b, t quarks
4. Particle Interactions
    a. Virtual particles and range of forces
    b. Strong and weak decays, conservation rules
    c. Parity, charge conjugation, CP
    d. Weak decays of quarks
    e. Colour charge, QCD, gluons
    f. Charmonium and upsilon systems
5. Electroweak Interactions
    a. Charged and neutral currents
    b. W, Z, LEP experiments
    c. Higgs and the future
6. LHC Experiments
7. Future – introduction to accelerator physics

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Learning Outcomes

By the end of the module the student should be able to:

- Perform calculations using relativistic kinematics to evaluate energies, momenta and masses in particle interactions
- Perform calculations involving the mean lifetime of unstable particles
- Perform calculations using the cross-sections of particle interactions
- Understand and use the standard terminology and nomenclature of particle physics
- Explain how the strength and range of a force are related to the properties of the intermediate force-carrying boson
- Describe the quark model of mesons and baryons
- Explain the flavour and colour quantum numbers of quarks and discuss the evidence for their existence
- Compare the properties of photons and gluons and the theories of quantum chromodynamics (QCD) and quantum electrodynamics (QED)
- Describe and recognise the characteristic properties of and differences between strong, weak and electromagnetic interactions and decays
- State and apply conservation rules for particle interactions
- Discuss the ideas of parity and charge-conjugation in particle physics
- Describe the physics of flavour-changing particle interactions and the Cabibbo-Kobayashi-Maskawa quark-mixing matrix
- Discuss the physics of the charmonium and upsilon systems, including the idea of Zweig-suppressed decays
- Describe the physics of electroweak interactions, the properties of W, Z and Higgs bosons and the results from the experiments at the Large Electron-Positron (LEP) Collider
- Describe the main methods by which a (boson with properties compatible with those of a) Standard Model Higgs was discovered at the LHC in July 2012.