

Course Component Outline for P404H Particle Physics.

Part I

Review: Fundamental Forces and Particles

Standard Model fermions and bosons; Standard Model structure; Common mesons and baryons.

Feynman Diagrams

Relationship to transition probabilities in QM; Basic QED diagrams and coupling constant; From Quark Parton Model to QCD (refer back to core course), the need for colour; QCD gluon self-coupling diagrams and running coupling constants; Partons \rightarrow hadrons and formation of jets of hadrons.

Experimental QCD

Deep inelastic scattering: kinematics and scaling, direct observation of partons; Scaling violations, first indications of gluons; Jets in e^+e^- , from low energy to high energy; Mercedes events; Measurement of R in e^+e^- , colour, number of flavours, running of α_s and first sight of the Z .

Accelerators and Detectors

Luminosity and cross-sections; Fixed target vs collider: energy reach (Higgs) vs rate (rare B-decays); Colliders: linac vs circular, synchrotron radiation (electron vs proton), RF bunching; Detectors: fixed target, collider; Detector elements: tracking, calorimetry, muons, triggering; Particle signatures in a typical detector; Neutrino experiment detectors.

Electroweak

Gauge theories: gauge symmetries \rightarrow bosons, introduction of $W+Z$; Problems with massive $W+Z$ s \rightarrow the Higgs boson.

Part II

Experimental Electroweak

Z^0 Breit-Wigner Resonance and the number of neutrinos: resonances and partial width, measurement of N_ν LEP; $e^+e^- \rightarrow W^+W^-$: ratios of hadronic to semi-leptonic to leptonic decays by counting states.

Higgs searches

Higgs decays: coupling to mass and decays for different Higgs decays; Higgs searches at LEP; Higgs searches at the LHC.

Top Quark

Generations and anomalies: why do we need top?; Discovery of top.

Heavy Flavour Physics

GIM mechanism and the discovery of charm and J/Ψ ; Extension of GIM to 6 quarks CKM matrix; particle anti-particle Oscillations; CP violation.

Neutrinos

Neutrinos: Parity and helicity of neutrinos; Neutrino oscillations and the solar neutrino puzzle; Example Neutrino experiment, SNO ; Neutrino masses.

Beyond the Standard Model Supersymmetry; Dark Matter; Grand Unified Theories;