School of Mathematics

MA4447 — The Standard Model of Elementary Particle Physics 2011-12
(SS Theoetical Physics
SS Mathematics)

Lecturer: Prof. S. Sint

Requirements/prerequisites: JS TP Mathematics modules (MA3432, MA3442, MA3444)

Duration: 11 weeks

Number of lectures per week: 3 including tutorials

Assessment:

ECTS credits: 5

End-of-year Examination: 2-hour exam in Trinity Term (April/May)

Description: This module provides an introduction to Elementary particle physics and its Standard Model (SM) for Senior Sophister students. Although the SM is an example of a Quantum Field Theory (QFT) no prior knowledge of QFT will be assumed (however, the SS course on QFT might be helpful/complementary). The basic structure of the SM will mostly be worked out by building on notions from classical Field Theory. Starting from the relativistic wave equations for both bosons and fermions, symmetry principles lead to the concept of gauge theories as a description of the fundamental interactions among particles. The need to render some of the gauge bosons massive leads to the Goldstone theorem and the Higgs mechanism as central ingredients for the electroweak sector of the SM. In particular, the coupling of a particle to the Higgs field determines its mass. The structure of the induced mass matrices provides a mechanism for the breaking of CP symmetry, which has been experimentally observed since the 1960's. Another pillar of the SM is Quantum Chromo Dynamics (QCD), with its postulated confinement of quarks and their asymptotic freedom. I will discuss the basic properties of QCD, the expected spectrum of hadronic states, as well as an effective low energy description of QCD in terms of pions and kaons (i.e. the lightest hadrons).

During the course some shortcomings of the SM will be exposed and it will hopefully become clear why most physicists believe that the LHC is well positioned to address some of the open questions.

September 7, 2011