The Standard Model (L24)

Professor D. Tong

The Standard Model is, by any measure, the most successful scientific theory of all time. The culmination of 350 years of scientific enquiry, it correctly explains every experiment that we've ever done (at least if you're willing to turn a blind eye to gravity for now). The purpose of this course is to explain the ingredients that go into the Standard Model, and the way in which they fit together.

In many ways, this course can be thought of as "QFT 3". We will cover many concepts that are widely applicable to any quantum field theory. In particular, there will be a focus on symmetries, including global symmetries, gauge symmetries, Poincaré symmetries, and discrete symmetries such as C,P and T. Associated to many of these symmetries is the idea of "symmetry breaking" and, to this end, we will prove Goldstone's theorem and explain the Higgs mechanism.

There will also be a focus on mathematical consistency. A phenomenon known as "anomaly cancellation" means that certain features of the Standard Model cannot be any other way: they are rigid and fixed. So you cannot, for example, have an electron-type particle without also having quarks and neutrinos. Other parts of the Standard Model appear to be much less rigid, especially those concerning the various interactions with the Higgs boson, usually referred to as "flavour", and these too will be described in detail. We will end the course by describing the open problems that remain with the Standard Model and ideas for theories that may, ultimately, replace it.

Prerequisites

You should be comfortable with the material from the Michaelmas term courses on QFT and Symmetries. It will also be useful to attend Advanced Quantum Field Theory in Lent.

Literature

I have previously written lecture notes for a baby version of this course that uses only high school mathematics. These notes describe the zoo of particles and how the various elements of the Standard Model fit together and may provide useful background. They can be downloaded at http://www.damtp.cam.ac.uk/user/tong/particle.html. (Rest assured, the actual course will use mathematics that you most definitely did not see in high school.)

Some books thay may be worth consulting are

1. David Griffiths, *Introduction to Elementary Particles*, Wiley, 2008
2. Matt Schwartz, *Quantum Field Theory and the Standard Model*. Cambridge University Press, 2014.
3. Cliff Burgess and Guy Moore, *The Standard Model: A Primer*, Cambridge University Press, 2007.

Additional support

Four examples sheets will be provided and four associated examples classes will be given. There will be a one-hour revision class in the Easter Term.