Lecture summaries

Field theory and the Standard Model: A symmetry-oriented approach

The Standard Model of particle physics represents the cornerstone of our understanding of the microscopic world. In these lectures we review its contents and structure, with a particular emphasis on the central role played by symmetries and their realization. This is not intended to be an exhaustive review but a discussion of selected topics that we find interesting, with the specific aim of clarifying some subtle points and potential misunderstandings. A number of more technical topics are discussed in separated boxes interspersed throughout the text.

Neutrino physics

This is an update of the lectures previously published in arXiv:1708.01046. The topics discussed in this lecture include: general properties of neutrinos in the SM, the theory of neutrino masses and mixings (Dirac and Majorana), neutrino oscillations both in vacuum and in matter, as well as an overview of the experimental evidence for neutrino masses and of the prospects in neutrino oscillation physics. We also briefly comment on the relevance of neutrinos in leptogenesis and in beyond-the-Standard-Model physics.

Flavour physics

We explain the reasons for the interest in flavor physics. We describe flavor physics and the related CP violation within the Standard Model, with emphasis on the predictions of the model related to features such as flavor universality and flavor diagonality. We describe the flavor structure of flavor changing charged current interactions, and how they are used to extract the CKM parameters. We describe the structure of flavor changing neutral current interactions, and explain why they are highly suppressed in the Standard Model. We explain how the B-factories proved that the CKM (KM) mechanism dominates the flavor changing (CP violating) processes that have been observed in meson decays. We explain the implications of flavor physics for new physics, with emphasis on the "new physics flavor puzzle", and present the idea of minimal flavor violation as a possible solution. We explain the "Standard Model flavor puzzle", and present the Froggatt–Nielsen mechanism as a possible solution. We show that measurements of the Higgs boson decays may provide new opportunities for making progress on the various flavor puzzles. We briefly discuss two sets of measurements and some of their possible theoretical implications: $R(K^{(*)})$ and $R(D^{(*)})$.