

08.128.742 The Standard Model and Electroweak Theory

Quantum Field Theory III

Instructor: Felix Yu (yu001@uni-mainz.de)

- Lectures: Wednesdays and Thursdays, 2:00-4:00 pm (c.t.) on Zoom
- Discussion/homework sessions: Approximately every second Thursday
- Homework: due at the beginning of each discussion session by e-mail (photo or scan) to yu001@uni-mainz.de
- Exam: Oral exams on request.
- Exam requirement: 50% of homework credits

Main topics (preliminary)

Standard Model Review color and electroweak gauge symmetries, field content of the Standard Model

Higgs and gauge bosons, Electroweak interactions Review Higgs mechanism and gauge boson masses; Unitarity violation in longitudinal gauge boson scattering; Peskin-Takeuchi oblique parameters; dim-6 SMEFT

Higgs and SM fermions, Flavor physics SM Yukawa interactions; Absence of tree-level flavor-changing neutral currents; New Physics Flavor Problem; Origin of CKM and PMNS matrices; Penguin diagrams

Higgs sector extensions Two-Higgs doublet models; singlet scalar extensions

Quark flavor physics Experimental determination of CKM elements; GIM mechanism

Bottom physics Belle II and historic $e^+e^- \rightarrow \Upsilon_{4s}$ flavor factories; b -tagged jets and displaced vertices

Top physics LHC as a top factory; The top quark role in Higgs physics; The top quark role in New Physics; Top probes of FCNCs and CPV

Strange, charm physics $K_0 - \bar{K}_0$ mixing, $D - \bar{D}$ mixing, CP violation

Lepton flavor physics Experimental determination of PMNS elements; $\mu \rightarrow e$ searches

Neutrino masses Dirac vs. Majorana fermions; Neutrino mass models; ν -less double beta decay

Collider physics Parton interactions; Parton distribution functions; Parton showers; Fragmentation and hadronization; Jet physics and jet algorithms; Jet substructure; Sudakov logarithms; Drell-Yan production

Primary reference

Lecture notes The lecture notes (both the remote notepad and the lecture notes themselves) will be uploaded to Moodle and will serve as the primary reference. Additional arXiv or textbook references for specific topics will be given upon request.

Secondary references

Michael Peskin, Daniel Schroeder An Introduction to Quantum Field Theory, Westview Press, 1995, ISBN 0-201-50397-2

Matthew D. Schwartz Quantum Field Theory and the Standard Model, Cambridge University Press, 2013, ISBN 1107034736