08.128.742 The Standard Model and Electroweak Theory

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

- Lectures: Mondays, 14:00-16:00 (c.t.) and Thursdays, 14:00-16:00 (c.t.) in Galilei room, 01-128, Staudinger Weg 9
- Discussion/homework sessions: Approximately every second Thursday
- Homework: due at the beginning of each discussion session
- Exam: Oral exams on request.
- Exam requirement: 50% of homework credits

Main topics

Motivation The Standard Model vs. A Standard Model; Open problems in the Standard Model;

Standard Model at tree-level EW gauge bosons and Higgs mechanism; Fermion masses, EWSB and global symmetries; CKM matrix and PMNS matrix; Yukawa interactions; Absence of tree-level flavor-changing neutral currents; New Physics Flavor Problem; CP violation; W and Z boson tree-level decays vs. Higgs decays; Perturbative unitarity in gauge boson scattering; Anomaly cancellation

SM quark and lepton phenomenology SM particle decay channels and lifetimes; Fermi interaction and semi-leptonic decays; Parton model and hadronization; Effective Electroweak Hamiltonian

Detector physics Parton showers, real radiation, 1-loop vertex corrections; KLN theorem; Sudakov logarithms; Hadronization and jet physics;

Collider physics Tree-level matrix elements and hard scattering diagrams vs. lepton and hadron colliders; Parton model; Parton distribution functions; Bjorken scaling; $pp \to jj$ calculation; Drell-Yan processes; DGLAP equations, Altarelli-Parisi splitting kernels

Standard Model at 1-loop Higgs physics; CP violation in EW sector; Penguin diagrams; Meson mixing; GIM mechanism; Lepton flavor violation; Peskin-Takeuchi oblique parameters

Effective Standard Model Theory Dimension-6 SMEFT; Majorana neutrino mass operator; Dirac vs. Majorana fermions; ν-less double beta decay

New Physics completions Neutrino seesaw models; DM EFT and simplified models

Primary reference

Lecture notes The lecture notes 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