MITP Summer School 2018: Towards the Next Effective Quantum Field Theory of Nature

Effective Field Theories

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Lecture 1: Introduction [1]

1. Basic terminology, steps in the construction of an effective theory
2. Operator dimension
3. Why effective theories?

Lecture 2: Construction of $\mathcal{L}_{\text{eff}}$

1. QED at very low energy: the Euler-Heisenberg Lagrangian [2]
2. Equation-of-motion operators
3. Matching, $\gamma\gamma$ scattering at low energies
4. Power counting and loop corrections
5. SMEFT

Lecture 3: Renormalization in effective field theories [3]

1. Fermi theory for charged-current quark decay
2. Renormalization and operator mixing, renormalization group (RG)
3. Resummation by RG-evolution: RG improved perturbation theory

Lecture 4: Modern Effective Field Theory [4, 5]

1. Soft Effective Theory: soft photons in electron scattering
2. Expansion of loop integrals and the method of regions

References

[1] T. Becher, Effective Field Theories, `http://www.becher.itp.unibe.ch/eft/index.html`. The web site has a list with many more references. The few given below are intended to provide further reading on the selected topics covered in the lectures.

[2] A. G. Grozin, "Introduction to effective field theories. 1. Heisenberg-Euler effective theory, decoupling of heavy flavours," arXiv:0908.4392 [hep-ph].

[3] A. J. Buras, "Weak Hamiltonian, CP violation and rare decays," hep-ph/9806471.

[4] T. Becher, "Les Houches Lectures on Soft-Collinear Effective Theory," arXiv:1803.04310 [hep-ph].

[5] T. Becher, A. Broggio and A. Ferroglia, "Introduction to Soft-Collinear Effective Theory," Lect. Notes Phys. **896**, pp.1 (2015) [arXiv:1410.1892 [hep-ph]].