



LECTURE COURSE IN THE QUANTUM UNIVERSE RESEARCH SCHOOL

Summer Term 2023

Renormalization of spontaneously broken gauge theories and related phenomenological aspects

Georg Weiglein

Course Description:

Spontaneously broken gauge theories play a crucial role in the description of the fundamental interactions of nature. The exploration of such theories at the quantum level requires a renormalisation in order to determine the physical meaning of the model parameters. The concept of renormalisation of spontaneously broken gauge theories is introduced and it is pointed out where the formalism of asymptotic in- and out-states in quantum field theories needs to be extended in order to allow the treatment of unstable particles. Conceptual problems in this context are discussed. As application of the developed methods several phenomenological aspects are highlighted.

Specifically the following topics will be covered:

- Quantum Field Theory (QFT): in- and out-states, S matrix, LSZ formalism; the problem of treating unstable particles in QFT
- The complex pole and the mass of an unstable particle
- On-shell, \overline{MS} and \overline{DR} renormalisation
- Renormalisation group equations
- Field renormalisation of unstable particles
- Finite wave function normalisation factors
- Vacuum expectation values and tadpoles
- Examples of applications

Prerequisites:

Basic knowledge in Quantum Field Theory at the level of the courses “Quantum Field Theory I” or “Advanced Particle Physics”.

Literature:

- M. Böhm, A. Denner, H. Joos, *Gauge Theories of the Strong and Electroweak Interaction* (Teubner)
- J. Collins, *Renormalization* (Cambridge Monographs on Mathematical Physics)

Date and Place: Fri 11:15–12:45, SemRm 2, Building 2a, Bahrenfeld

Starting on: 14 April 2023
