

Project:

Studying Coleman-Weinberg effective models for microscopic description of the Higgs mechanism

The Brout-Englert-Higgs (BEH) mechanism is one of the keystones of the Standard Model of elementary particles. In fact it is crucial provide masses to (electro)weak gauge bosons and fermions, which otherwise would be impossible without explicit breaking of gauge symmetries. The realization of this mechanism in Standard Model made the latter the most successful physical theory ever. Nevertheless, the mechanism itself is introduced at the semi-classical level and looks as an effective macroscopic description of the spontaneous symmetry breaking like the Ginzburg-Landau superconductivity model. Moreover the Brout-Englert-Higgs mechanism leads to the so-called naturalness problem of the Standard Model. To find a microscopic (i.e. quantum field theory) version of the BEH mechanism is one actual problems in the contemporary theory of elementary particles. In particular there were many attempts to construct models where the Higgs boson is not fundamental but a composite particle. Within the project we will consider an alternative approach to reproduce the BEH mechanism with the help of the Coleman-Weinberg effective potential approach. Two simple models will be considered: one with a single scalar field with quartic self-interaction ϕ^4 and the one with additional Yukawa interaction of the same scalar field with a fermion. The task will be to study the behavior of one-loop effective potentials of these models and construction of the corresponding effective theories in the vicinity of the effective potential minima.

The requirement for students is basic knowledge of the classical and quantum field theory.

Literature:

[1] L.H. Ryder, Quantum field theory

[2] Wikipedia: Higgs mechanism

[3] S.R. Coleman and E.J. Weinberg,

``Radiative Corrections as the Origin of Spontaneous Symmetry Breaking,"
Phys. Rev. D 7 (1973) 1888. [arXiv:hep-th/0507214](https://arxiv.org/abs/hep-th/0507214)

[4] Wikipedia: Coleman–Weinberg potential