

Abstract for the general public

All the Standard Model (SM) particles including the Higgs boson are copiously produced at the LHC and other accelerator experiments. On the other hand, no production of new (beyond-SM) ones has been observed so far. Existence of new particles is indicated by astrophysical evidence for dark matter. Moreover, several (debatable) deviations from the SM predictions in low-energy measurements suggest that such particles are much heavier than the SM ones, but still within the range for possible production in the late-21st-century experiments that are currently being planned.

Many SM extensions that have been proposed so far assume weakly interacting new particles being much heavier than the heaviest SM one. In such models, when analyzing phenomena at energies much lower than the lightest new particle mass, it is convenient to pass to an effective theory by the so-called decoupling all the new particles. Such an effective theory is called the Standard Model Effective Field Theory (SMEFT). It has the SM particle content and imposed symmetries, but allows for many more interactions than the original SM.

The SMEFT parameters that determine the strength of the extra interactions are called the Wilson coefficients. They are not constants but depend on the scale μ that should be close to the maximal energy-momentum transfer in the considered process. Their dependence on μ is governed by differential equations called the Renormalization Group Equations (RGEs).

A similar technique is used for analyzing processes mediated by weak interactions in the SM at scales that are much lower than the W -boson mass. Starting from the full SM, we decouple the W -boson and all the heavier particles, obtaining an effective theory that is called Weak Effective Theory (WET). It has its own Wilson coefficients and its RGEs.

Within the current research project, we plan to determine the RGEs in a generic class of effective theories that includes both the SMEFT and the WET. Moreover, in the framework of WET, we plan to carry out calculations that aim at improving precision in the SM predictions for probabilities of several decays of the B meson. The decays we choose are either directly sensitive to possible existence of new particles or help in improving this sensitivity in an indirect manner, by providing means for precise determination of the relevant SM parameters.