Description of doctoral project
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Heavy Quark Mass Renormalization Schemes in QCD

In my doctoral projects, under supervision of Univ.-Prof. Dr. André Hoang, my collaborators and I investigated different aspects of heavy quark masses in the theory of strong interactions (Quantum Chromodynamics, QCD). Heavy quark masses play a crucial role in many phenomenological applications in QCD, either because they represent important corrections in precision calculations or because they introduce conceptual complications.

One of the main results of my thesis projects was the MSR mass renormalization scheme. In Quantum Field Theories (such as QCD), one usually has the problem that the quantities one wants to compute, the amplitudes, are initially divergent. However, it is possible to redefine the parameters of the theory such that the divergences are cancelled in a systematic way. This is called "renormalization". In addition to the purely divergent terms, one can also absorb arbitrary finite contributions, which gives rise to so-called "renormalization schemes".

The MSR mass renormalization scheme we developed is especially suitable for applications at low energies. Together with the associated renormalization group equation, the MSR mass can be used to make conversions between schemes more precise and to investigate subtile issues related to quark mass renormalization in QCD (e.g. the "pole mass renormalon"). A renormalization group equation can be thought of as a differential equation that describes how the values of masses and couplings behave at different energy scales. In the case of the MSR mass this equation is called the "R-evolution equation".

Recently, I have worked on `REvolver`, a `C++` library with additional `Mathematica` and `Python` interfaces. `REvolver` implements the MSR mass and the related concepts in a user-friendly way, and is aimed both at theorists and experimentalists.

The provided functionalities include exact renormalization group running of the MSR mass (as well as for its much older high-energy variant, the $\overline{\text{MS}}$ mass, and the strong coupling), conversions between various mass renormalization schemes, and the extraction of various other QCD-related quantities.