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Automatisation of Integrating out heavy fields at one-loop

The success of the Standard Model (SM) and the lack of direct evidence of any beyond Standard Model (BSM) particles impels us to look for indirect shreds of evidence. The effective field theory framework is just the right tool for that. We can treat the SM as an effective theory by adding higher dimensional terms to its Lagrangian and trying to capture the footprint of the more complete UV theory, this is commonly known as the bottom-up approach. On the other hand, we can choose a complete UV theory, identify the heavy degrees of freedom, integrate them out and obtain operators of higher mass dimension, known as the top-down approach. Covariant Derivative Expansion (CDE) is one of the methodologies that integrate out heavy fields and generate the effective operator and their Wilson coefficient. The two most intriguing traits of CDE are, firstly, the method is manifestly gauge-invariant so the effective operators generated at the end are also gauge-invariant. Secondly, its applicability is universal. Encapsulating these features there is a formula dubbed as the universal one-loop effective action (UOLEA) which has algorithmic essence to it. The Mathematica based package CoDEx based on the UOLEA is one of the tools that can integrate out heavy particles from the tree as well as one-loop diagrams and generate effective operators of mass dimension-6. It provides the operators in two different bases: "Warsaw" and "SILH" and can perform the renormalisation group evolutions (RGE) of operators to some low energy scales.

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