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FeynCalc goes multiloop

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FeynCalc is esteemed by many particle theorists as a very useful tool for tackling symbolic Feynman diagram calculations with a great amount of transparency and flexibility. While the program enjoys an excellent reputation when it comes to tree level and 1-loop calculations, the usefulness of FeynCalc in multi-loop projects is often doubted by the practitioners.

In this talk I will report on the upcoming version of the package aiming to address these shortcomings. In particular, FeynCalc 10 will introduce a number of new routines that facilitate two very important steps of almost every multi-loop calculation.

The first one concerns the identification of the occurring multi-loop topologies including the minimization of their number by finding suitable mappings between integral families.

The second one deals with the handling (visualization, expansions, analytic evaluation) of master integrals obtained after a successful IBP reduction of multiple integral families.

In FeynCalc 10 these nontrivial operations are implemented in the form of versatile and easy-to-use functions such as FCLoopFindTopologyMappings, FCLoopIntegralToGraph or FCFeynmanParametrize etc. that will be introduced in my presentation.

Significance

The task of identifying and minimizing the number of loop integral topologies addressed in my talk is not something sufficiently well covered by the publicly available software, although the relevant algorithms are available since long time (cf. https://arxiv.org/abs/1111.0868 and in particular and https://doi.org/10.5445/IR/1000047447). Here multi-loop practitioners tend to rely on their private codes (e.g. q2e/exp from KIT) or Reduze 2 which, however, often lacks the desired flexibility.

The ability to carry out this crucial step of virtually every multi-loop calculation using FeynCalc is, therefore, a large step forwards towards the goal of making such calculations accessible to numerous HEP theorists instead of a small number of specialized research groups.

This goes hand in hand with the second main aspect of my talk that discusses useful manipulations of master integrals using FeynCalc. This includes not only the derivation of Feynman parametrizations suitable for analytic integration and evaluation in terms of GPLs (e.g. using HyperInt or PolyLogTools) but also the visualization of the integrals by converting them from propagator into graph representation (cf. https://github.com/FeynCalc/feyncalc/blob/master/FeynCalc/DocumentationFiles/Markdown/FCLoopGraphPlot.md for some examples of what is already possible) and of course mappings between masters from different integral families.

On the one hand, the new multi-loop capabilities of FeynCalc make use of many ideas from FIRE, LiteRed, pySecDec, TopoID and of course Alexey Pak. On the other hand, having all these routines available at a fingertip in a unified framework (including documentation and examples) significantly lowers the bar for nonexperts to embark on multi-loop calculations.

In this sense the presented work has great potential to challenge the status quo in the field of higher order perturbative calculations, where only selected groups possess the technical know how required for an efficient evaluation of Feynman diagrams beyond 1-loop.

References

Previous publications on FeynCalc with my name in the list of authors.

https://arxiv.org/abs/1601.01167
https://arxiv.org/abs/1611.06793
https://arxiv.org/abs/2001.04407
https://arxiv.org/abs/2006.15451

Speaker time zone

Compatible with Europe

Primary author: SHTABOVENKO, Vladyslav (KIT)

Presenter: SHTABOVENKO, Vladyslav (KIT)

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