Contribution ID: **449** Type: **Oral**

Toward an efficient evaluation of two-loop massive scalar integralss

Monday, 11 March 2019 18:00 (20 minutes)

A key ingredient in an automated evaluation of two-loop multileg processes is a
fast and numerically stable evaluation of scalar Feynman integrals. In this respect, the calculation of two-loop three- and four-point functions in the general complex mass case so far relies on multidimensional numerical integration through sector decomposition whereby a reliable result has a high computing cost, whereas the derivation of a fully analytic result remains beyond reach. It would therefore be useful to perform part of the Feynman
parameter integrations analytically in a systematic way to let only a reduced
number of integrations to be performed numerically. Such a working program has been initiated for the calculation of massive two-loop N-point functions
using analytically computed building blocks. This approach is based on the implementation of two-loop scalar N-point functions in four dimensions ${}^{(2)}I_N^4$ as double integrals in the form:
\$ ${}^{(2)}I_N^4 \sim \sum \int_0^1 d\rho \int_0^1 d\xi \, P(\rho,\xi) \; {}^{(1)}\widetilde{I}_{N+1}^4(\rho,\xi)$ *wherethebuildingblocks*^{(1)}\widetilde{I}{N+1}^{4}(\rho,\xi)*involvedintheintegrands*
loop(N+1)−pointFeynman−typeintegrals, andwhereP(\rho,\xi)areweightingfunctions.The^{(1)}\widetilde{I}{N+1}^{4}(\rho,\xi)*ar*
0 \leq z_{j} \leq 1, j = 1,\cdots,N+1; \sum_{j=1}^{N+1} z_{j}=1\}*atworkfortheone−loop*(N+1)−*pointfunction, butanotherdomain(e.g.c*
*loop*N−*pointfunctionconsidered.Thegeneralisationconcernsalsotheunderlyingkinematics, which, besidesexternalmoment*
loop(N+1)−*particleprocessesatcolliders.Theonlytworemainingintegrationsover*\rho,\xi*tobeperformednumericallyrepresen*
loopintegrals.

As a first step in this direction, the method developped has been successfully applied to the usual one-loop four-point function for arbitrary masses and kinematics as a "proof of concept", showing its ability to circumvent the subtleties of the various analytic continuations in the kinematical variables in a systematic way, in a series ofthree articles. The target work, namely its practical implementation to compute the building blocks $\{(1)\}\backslash widetilde\{I\}\_\{N+1\}\{4\}(\backslash rho,\backslash xi)$ *\$istobeelaboratedandpresented inafutureseriesofarticles.*

Primary authors: Mr GUILLET, Jean-Philippe (LAPTh CNRS); Mr PILON, Eric (LAPTh CNRS); Mr SHIMIZU, Yoshimitsu (KEK); Mr ZIDI, Sadek (Jijel University, Algeria)

Presenter: Mr GUILLET, Jean-Philippe (LAPTh CNRS)

Session Classification: Track 3: Computations in Theoretical Physics: Techniques and Methods

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