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3-loop Feynman integrals in the Euclidean or physical kinematical region

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We recently explored methods for 2-loop Feynman integrals in the Euclidean or physical kinematical region, using numerical extrapolation and adaptive iterated integration. Our current goal is to address 3-loop two-point integrals with up to 6 internal lines.

Using double extrapolation, the integral $\mathcal{I}$ is approximated numerically by the limit of a sequence of integrals $\mathcal{I}(\varepsilon)$ as $\varepsilon \to 0$, where ε enters in the space-time dimension $\nu = 4 - 2\varepsilon$. For a fixed value of $\varepsilon = \varepsilon_\ell$, the integral $\mathcal{I}(\varepsilon_\ell)$ is approximated by the limit of a sequence $I(\varepsilon_\ell, \varrho)$ as $\varrho \to 0$. Here, ϱ enters in the modification of a factor V to $V - i\varrho$ in the integrand denominator, applied since V may vanish in the integration domain. Alternatively, we can integrate after expanding with respect to ε, followed by a single extrapolation in ϱ only.

In this work, we will give an analysis with applications to sample diagrams.

Significance

Accurate theoretical predictions are needed in view of improvements in the technology of high energy physics experiments. Higher-order corrections are required for accurate theoretical predictions of the cross-section for particle interactions. The Feynman diagrammatic approach is commonly used to address higher-order corrections. We use numerical integration and extrapolation methods to handle integrand singularities in Feynman loop integrals.

References

Paper on 2-loop integrals in ACAT 2022: "Loop integral computation in the Euclidean or physical kinematical region using numerical integration and extrapolation", E. de Doncker, F Yuasa, T. Ishikawa and K. Kato

Experiment context, if any

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