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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  $\varepsilon$  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,  $\varrho$  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  $\varepsilon$ , followed by a single extrapolation in  $\varrho$  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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