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Regularization of IR-divergent loop integrals

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We report results of a new regularization technique for infrared (IR) divergent loop integrals using dimensional regularization, where a positive regularization parameter (epsilon, satisfying that the dimension d = 4+2*epsilon) is introduced in the integrand to keep the integral from diverging as long as epsilon > 0.
Based on an asymptotic expansion of the integral we construct a linear system of equations, which incorporates values of the integral for varying epsilon in the right hand side of the system. The linear system is extended by one equation at a time for decreasing epsilon, and solved for the leading coefficients of the Laurent expansion of the integral. This gives rise to an extrapolation as epsilon tends to zero. The solutions can be obtained by solving the systems directly or by a recursive method.
We will outline the computations and the evaluation of the integrals for various problems. An analysis involves the condition and truncation error of the method. All computations are kept numerical and performed with automatic code, including a possible reduction of the integral to a form without entangled singularities. The basic technique can be applied to IR divergent integrals without (threshold) singularities in the interior of the domain. For non-IR divergent integrals with threshold singularities, the same method reduces to a linear extrapolation for a calculation of the integral. We outline an extension of the technique for integrals which have both types of singularities by resorting to a double extrapolation or regularization.

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