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Integration-by-parts identities and multi-loop QCD amplitudes

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As the LHC gathers ever more data and makes measurements with increasingly high precision, it is essential for theorists to match this precision when making predictions for cross-sections. In QCD and other gauge theories, this high precision is achieved by including multi-loop Feynman diagrams when calculating scattering amplitudes. Integration-by-parts identities (IBPs) are widely used when computing the associated multi-loop integrals. The solution of large systems of IBPs is a major bottleneck in the computation of high-precision QCD amplitudes for processes observed at the LHC, such as 3-jet production.
In this talk, I will discuss my work on IBPs, first presented in arXiv:1805.09182, where we introduce a new strategy for solving systems of IBPs, which we believe to be especially applicable to problems with many kinematic scales and/or many master integrals. Using this strategy, we have solved the IBPs needed for the computation of any planar 2-loop 5-point massless amplitude in QCD. We have also derived some new results for the associated non-planar integrals. Ultimately, we expect that the remaining non-planar contributions will be computable in analytic form, which would allow cross-sections for processes such as 3-jet production to be predicted at Next-to-next-to-leading order in QCD, reducing theoretical uncertainties down to a few percent.

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