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Feynman Integral Relations from GKZ Hypergeometric Systems

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We study integration-by-parts-like relations and differential equations for Feynman integrals in the framework of $\mathcal{D}$-module theory. We leverage the fact that Feynman integrals satisfy a set of PDEs called a GKZ hypergeometric system. This fact allows us to uniquely associate a Feynman integral to an element of a $\mathcal{D}$-module, which can be intepreted as a differential operator in external kinematic variables. We are thereby able to derive relations among integrals by studying relations among $\mathcal{D}$-module elements. In particular, integration-by-parts-like relations follow from reducing higher order differential operators to lower ones, and differential equations for Feynman integrals correspond to Pfaffian systems for a set of basis operators. We apply this philosophy to a couple of simple examples at 1- and 2-loops.

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