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Color-ordered form factors for the four-gluon amplitudes

The string-derived Bern-Kosower formalism was originally developed for the computation of on-shell gluon amplitudes. In previous work we have, using worldline methods, shown how to extend and optimize this formalism as a tool for obtaining form-factor decompositions of the off-shell 1PI gluon amplitudes. Following an earlier rederivation of the three-gluon (Ball-Chiu) form factor decomposition, here we present the first explicit form factor decomposition of the one-loop four-gluon amplitudes, unifying the scalar, spinor and gluon loop cases. As in the three-gluon case, this unification is made possible by the fact that the treatment of the gluon loop in the string-derived formalism is equivalent to the background field method in quantum Feynman gauge. Differently from the three-point case, however, at four points for achieving this unification it is also essential that the formalism naturally leads to a color-ordered form of the amplitudes. A particularly simple structure emerges in the $N=4$ SYM case.

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