In this paper the authors study one-loop contributions to the three-point gluon vertex function in QCD by use of string-theory inspired approach [1]; see also a review [2]. The contributions are calculated for scalar, spinor and gluon loops in a unified fashion. To be more specific and technical, the authors develop an improved version of the so-called Bern-Kosower formula for N-point gluon vertices [1] with imposition of gauge invariance and permutation invariance. A primordial version of these developments can be found in [3]; see also recent progress [4].

The resultant analytic expressions of the one-loop contributions are consistent with the previously known results on the three-point gluon vertex. In particular, the result shows clear connection with the Ball-Chiu decomposition rules [5] for the form factor of the three-point vertex. It also reproduces the Ward identity relations for scalar and fermion loop contributions, and the so-called Binger-Brodsky relation [6] among the massless scalar, spinor and gluon loop contributions. (The Binger-Brodsy relation can be interpreted as the vanishing of the one-loop vertex in $\mathcal{N} = 4$ super Yang-Mills theory.) These results provide insights into higher-loop calculations in QCD.

Notice that this paper focuses on three-point vertex. As a consequent, the technical developments are made independent of the helicity-spinor approach to the one-loop amplitudes in $\mathcal{N} = 4$ super Yang-Mills theory [7, 8]; where the one-loop amplitudes are calculated in the planar limit.

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