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Matching Singlet Axial-Vector and Topological Currents from (S)MOM to MS to Four Loops

The singlet axial-vector and topological current operators play central roles in determining the quark and gluon spin contributions to the proton spin. As a consequence of the Adler–Bell–Jackiw anomaly, the axial-vector current J_A^μ acquires a non-trivial renormalization starting at two loops in perturbation theory, which is closely related to the renormalization of the topological current. The determination of the renormalization constant for J_A^μ at high orders is complicated by the notorious difficulty of treating γ_5 in dimensional regularization. Employing an newly proposed efficient variant of Larin's renormalization condition for J_A^μ in dimensionally regularized QCD, we compute the finite matching coefficients from (S)MOM to $\overline{\rm MS}$ schemes up to unprecedented (3)4 loops. These results provide essential theoretical input for accurately converting (S)MOM-renormalized currents computed in lattice QCD to their $\overline{\rm MS}$-renormalized counterparts.

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