Determination of QCD strong coupling from Borel-Laplace sum rules for tau decay*

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Abstract:
A numerical analysis of pinched Borel-Laplace QCD sum rules for the strangeless semihadronic τ-decay data is performed. The dimension $D = 0$ contribution to the theoretical contour integral in the sum rules is evaluated by the (truncated) Fixed Order perturbation theory method and by the Borel integration with the Principal Value. The full Adler function is represented in the form of the Operator Product Expansion (OPE) with the terms $\sim \langle O_D \rangle$ of dimension $D = 2n$, where $D \leq 10$ for the (V+A)-channel and $D \leq 14$ for the V-channel data. The $D = 0$ part of the Adler function, $d(Q^2)_{D=0}$, is based on a renormalon-motivated construction of the Borel transform $\mathcal{B}[\tilde{d}](u)$ of a related auxiliary quantity $\tilde{d}(Q^2)$. The $u = 3$ infrared renormalon sector in $\mathcal{B}[\tilde{d}](u)$ contains the recently known information on the dominant two noninteger values $k^{(j)} = \gamma^{(1)}(O_6^{(j)})/\beta_0$ of the effective leading-order anomalous dimensions, i.e., the corresponding terms in $\mathcal{B}[\tilde{d}](u)$ are $\sim 1/(3-u)^{\kappa^{(j)}}$ where $\kappa^{(j)} = 1 - k^{(j)}$. The OPE of the Adler function has $D = 6$ term $\sim \langle O_6 \rangle \alpha_s^{k^{(2)}}(Q^2)/(Q^2)^3$ with the principal anomalous dimension $k^{(2)}$, and terms with $D = 4$ and $D \geq 8$ with zero anomalous dimension. We performed cross checks of the obtained extracted values of α_s and of the condensates, by reproducing the (central) experimental values of several pinched momenta $a^{(2,n)}$. The extracted averaged final value of the ($\overline{\rm MS}$) coupling is: $\alpha_s(m_\tau^2) = 0.3169^{+0.0070}_{-0.0096}$, which corresponds to $\alpha_s(M_Z^2) = 0.1183^{+0.0009}_{-0.0012}$.

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