Determination of the strong coupling from high-energy data

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We present a determination of the strong coupling constant, α_s, from a comprehensive global analysis of high-energy scattering data collected worldwide at the LHC, Tevatron, HERA and a number of fixed-target experiments [1,2]. This broad dataset provides sensitivity to α_s over a wide range of momentum scales and kinematic regimes, enabling a stringent test of perturbative Quantum Chromodynamics (QCD).

The theoretical description is based on next-to-next-to-leading order QCD predictions formulated in the $\overline{\rm MS}$ renormalization scheme, supplemented by leading-order Quantum Electrodynmicss effects in the parton evolution. Particular attention is paid to the treatment of deep-inelastic scatterin (DIS) data, where non-perturbative power corrections may affect the extraction of α_s. To suppress such contributions, we impose stringent kinematic cuts on the hadronic invariant mass squared, requiring $W^2 \geq 12.5$ GeV^2, together with a series of cuts on the momentum transfer squared Q^2. This strategy ensures that the analyzed data predominantly probe the perturbative regime where fixed-order QCD calculations are reliable.

By systematically studying the dependence of the extracted vlue of α_s on the applied Q^2 cuts, we demonstrate that the preferred value of α_s stabilizes once sufficiently restrictive cuts are imposed. In particular, when low-Q^2 DIS data that are sensitive to higher-twist effects are effectively removed, the resulting determination of α_s becomes robust and insensitive to further variations of the kinematic selection. Discarding explicit higher-twist contributions, we extract the value

$$\alpha_s(m_Z, N_f = 5) = 0.1152 \pm 0.0008,$$

for $N_f = 5$ light quark flavors using the cut $Q^2 > 10$ GeV^2.

In contrast, when less restrictive Q^2 cuts are applied in the absence of higher-twist terms, the quality of the fit deteriorates significantly, and the extracted values of α_s increases systematically, exhibiting an upward shift of approximately two standard deviations. This behavior provides clear evidence for the impact of power corrections in the low-Q^2 region and highlights the importance of a careful kinematic selection in precision determinations of α_s.

1. S. Alekhin, M.V. Garzelli, S. Moch, O. Zenaiev. arxiv:2510.21435
2. S. Alekhin, M.V. Garzelli, S. Moch, O. Zenaiev. Eur.Phys.J.C 85 (2025) 162 [arxiv:2407.00545]