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New analyses of event shapes and the determination of QCD α_s in e^+e^- annihilation

(Based on arXiv:2112.06212; 1908.00060; 1902.01984).

We give comprehensive analyses for event shape observables in electron-positron annihilation by using the Principle of Maximum Conformality (PMC). Conventionally, the renormalization scale and theoretical uncertainties in event shape observables are often evaluated by setting the scale to the center-of-mass energy $\sqrt{s}$. Only one value of the QCD coupling at the single scale $\sqrt{s}$ can be extracted. In contrast, the PMC renormalization scales change with event shape kinematics, and thus yield the correct physical behavior of the scale. The resulting PMC predictions agree with precise event shape distributions measured at the LEP experiment. We can precisely determine the running of the QCD coupling constant $\alpha_s(Q^2)$ over a wide range of Q^2 in perturbative domain from event shape distributions measured at a single center-of-mass energy $\sqrt{s}$.

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