

Top-Quark Decay at Next-to-Next-to-Next-to-Leading Order in QCD

We present the first complete high-precision QCD corrections to the inclusive decay width Γ_t , the W-boson helicity fractions and semi-inclusive distributions for the top-quark decay process $t \rightarrow b + W^+ + X$ at next-to-next-to-next-to leading order (NNNLO) in the strong coupling constant α_s . In particular, with the Standard Model parameters used in our calculations, the pure NNNLO QCD correction decreases the Γ_t by about 0.8% of the previous $\mathcal{O}(\alpha_s^2)$ result at the top-quark pole mass scale, exceeding the estimate by the conventional scale-variation.

Exploiting the scale dependence our best prediction for the complete QCD correction factor to the Born-level Γ_t is determined to be $\delta_{QCD} \approx 0.8833$ with an error $\pm 0.25\%$.

On the other hand, NNNLO QCD effects on W-helicity fractions are confirmed to be much smaller, at the level one or two per-mille for the dominating longitudinal one, predestining it to act as a precision observable for the top-quark decay process.

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