NEXT-TO SOFT VIRTUAL RESUMMED DRELL-YAN CROSS SECTION BEYOND LEADING-LOGARITHM

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Objective

- To present the resummed predictions for inclusive cross section for DY production up to next-to-next-to leading logarithmic ($\overline{\text{NNLL}}$) accuracy taking into account both soft virtual (SV) and next-to SV (NSV) threshold logarithms.

Formalism

- In the QCD improved parton model, the invariant mass distribution of a pair of leptons produced in hadron colliders can be expressed as a convolution of perturbatively calculable coefficient functions (CFs), Δ_{ab}, and non-perturbative flux $\tilde{\Phi}_{ab}$.

$$\frac{d\sigma}{dQ}(q^2,\tau) = \sigma^{(0)}_{DY} \int_\tau^1 \frac{dz}{z} \tilde{\Phi}_{ab}\left(\frac{\tau}{z},\mu_F^2\right) \Delta_{ab}(q^2,\mu_F^2.z)$$

- For instance, the generic form of any partonic coefficient function, Δ_{ab} , near threshold $z \to 1$:

$$\Delta^{(i)}_{ab}(z,q^2) = \sum_{k=0}^{2i-1} c^{\mathcal{D}}_{ik}\ \mathcal{D}_k + c^{\delta}_{i}\ \delta(1-z) + \sum_{k=0}^{2i-1} c^{L}_{ik}\ \ln^k(1-z) + \mathcal{O}(1-z)$$

- Key points to compute the CFs - Factorisation and Renormalisation group (RG) invariance. For the diagonal channels, the SV+NSV partonic coefficient function can be factorised

$$\begin{aligned}\Delta_I^{SV+NSV}(z,q^2,\mu_F^2,\mu_R^2,\epsilon) &= \left(Z_{UV,I}(\hat{a}_s,\mu_R^2,\mu^2,\epsilon)\right)^2 |\hat{F}_I(\hat{a}_s,\mu^2,q^2,\epsilon)|^2 \times \delta(1-z) \otimes \mathcal{S}_I\left(\hat{a}_s,\mu^2,q^2,z,\epsilon\right) \\ &\otimes \Gamma^{-1}_{II}\left(\hat{a}_s,\mu^2,\mu_F^2,z,\epsilon\right) \otimes \Gamma^{-1}_{\bar{I}\bar{I}}(\hat{a}_s,\mu^2,\mu_F^2,z,\epsilon)\end{aligned}$$

- Resummed CF in the Mellin N-space: $\Delta_{q,N}(q^2,\mu_R^2,\mu_F^2) = C_0^q(q^2,\mu_R^2,\mu_F^2)\exp\left(\Psi^q_N(q^2,\mu_F^2)\right)$

Results

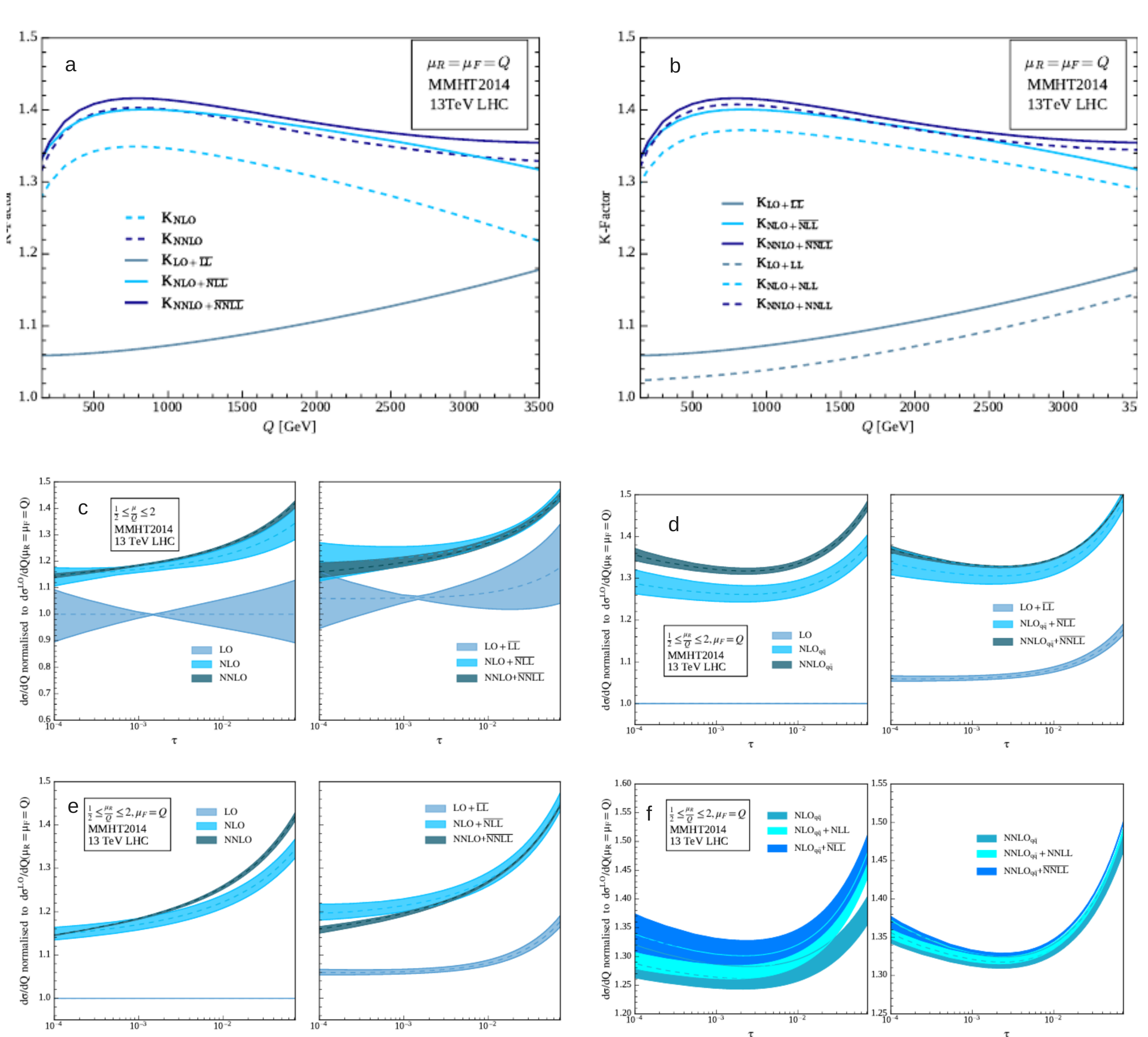

Figure 1: (a,b) K-factor, (c) 7-point variation ,(d) μ_R scale variation , (e) μ_R scale variation in $q\bar{q}$- channel, (f) comparison of μ_R scale variation in $q\bar{q}$-channels between SV and SV+NSV

Q	LO	LO+$\overline{\text{LL}}$	NLO	NLO+$\overline{\text{NLL}}$	NNLO	NNLO+$\overline{\text{NNLL}}$
1000	$2.3476^{+4.10\%}_{-3.92\%}$	$2.5184^{+4.49\%}_{-4.25\%}$	$3.1609^{+1.79\%}_{-1.69\%}$	$3.2857^{+2.08\%}_{-1.18\%}$	$3.2876^{+0.20\%}_{-0.31\%}$	$3.3191^{+1.13\%}_{-0.86\%}$
2000	$0.0501^{+8.50\%}_{-7.46\%}$	$0.0554^{+9.10\%}_{-7.91\%}$	$0.0654^{+2.83\%}_{-2.98\%}$	$0.0688^{+1.43\%}_{-1.23\%}$	$0.0684^{+0.37\%}_{-0.62\%}$	$0.0692^{+0.89\%}_{-0.78\%}$

Table 1: Values of resummed cross section in 10^{-5} pb/GeV at various orders in comparison to the fixed order results at different central scales $Q = \mu_R = \mu_F = 1000$ and 2000 GeV for 13 TeV LHC.

Conclusions

- The resummation, taking into account the NSV terms, appreciably increases the cross section while decreasing the sensitivity to renormalisation scale.
- At 13 TeV LHC energies, the SV+NSV resummation at $\overline{\text{NLL}}$($\overline{\text{NNLL}}$) gives about 8% (2%) corrections respectively to the NLO (NNLO) results for the considered Q range: 150-3500 GeV.
- The absence of quark gluon initiated contributions to NSV part in the resummed terms leaves large factorisation scale dependence indicating their importance at NSV level.

References

[1] A. H. A, P.Mukherjee, Ravindran, A.Sankar, and S.Tiwari. Next-to SV resummed Drell-Yan cross section beyond leading-logarithm. 7 2021.

[2] A. H. A, P.Mukherjee, and Ravindran. On next to soft corrections to Drell-Yan and Higgs Boson productions. 6 2020.