Issues in DY

I.S.

DY

$$h_1(P_1) + h_2(P_2) \to l(l) + l'(l') + X$$

$$s = (P_1 + P_2)^2, \quad q^2 = Q^2, \quad y = \frac{1}{2} \ln \frac{q^+}{q^-}$$

Bjorken Variables

$$x_{1,2} = e^{\pm y} \sqrt{\frac{Q^2 + \mathbf{q_T^2}}{s}}$$

DY

The hadronic tensor is proportional to (P’s are hadrons momenta)

$$g_T^{\mu\nu} = g^{\mu\nu} - \frac{2}{s}(P_1^\mu P_2^\nu + P_2^\mu P_1^\nu)$$

However the leptonic tensor is such that

$$\begin{aligned}
(-g_T^{\mu\nu})\hat{L}_{\mu\nu}^{GG'} &= 16\left(g_G^R g_{G'}^R + g_G^L g_{G'}^L\right)\int \frac{d^3l}{2E}\frac{d^3l'}{2E'}\delta^{(4)}(l+l'-q)((ll')-(ll')_T) \\
&= \left[2\left(g_G^R g_{G'}^R + g_G^L g_{G'}^L\right)\right]\frac{4\pi}{3}Q^2\left(1+\frac{\mathbf{q_T^2}}{2Q^2}\right), \\
(g_T^{\mu\nu} - 2\frac{q_T^\mu q_T^\nu}{q_T^2})\hat{L}_{\mu\nu}^{GG'} &= -32\left(g_G^R g_{G'}^R + g_G^L g_{G'}^L\right)\int \frac{d^3l}{2E}\frac{d^3l'}{2E'}\delta^{(4)}(l+l'-q)\frac{2l_T^2 l_T' + (ll')_T l_T^2 + (ll')_T {l'}_T^2}{q_T^2} \\
&= \left[2\left(g_G^R g_{G'}^R + g_G^L g_{G'}^L\right)\right]\frac{4\pi}{3}Q^2\frac{\mathbf{q_T^2}}{Q^2}.
\end{aligned}$$

And we have assumed no lepton cuts

Back up

DY

The transverse component are projected by the tensor orthogonal to P’s

$$g_T^{\mu\nu} = g^{\mu\nu} - \frac{2}{s}(P_1^\mu P_2^\nu + P_2^\mu P_1^\nu)$$

Integration on lepton cuts

$$\mathcal{P}_1 = \int \frac{d^3l}{2E}\frac{d^3l'}{2E'}\delta^{(4)}(l + l' - q)((ll') - (ll')_T)\theta(\mathrm{cuts}) \Big/ \left[\frac{\pi}{6}Q^2\left(1 + \frac{\mathbf{q_T^2}}{2Q^2}\right)\right]^{-1},$$

DY cross section

$$\frac{d\sigma}{dQ^2 dy d\mathbf{q_T^2}} = \frac{2\pi}{3N_c}\frac{\alpha_{\rm em}^2}{sQ^2}\sum_f \left[\left(1+\frac{\mathbf{q_T^2}}{2Q^2}\right)\mathcal{P}_1\, W_{f_1 f_1}^f\right]$$

$$\times\Big[z_l^{\gamma\gamma} z_f^{\gamma\gamma} + z_l^{\gamma Z} z_f^{\gamma Z}\frac{2Q^2(Q^2-M_Z^2)}{(Q^2-M_Z^2)^2+\Gamma_Z^2 M_Z^2} + z_l^{ZZ} z_f^{ZZ}\frac{Q^4(Q^2-M_Z^2)}{(Q^2-M_Z^2)^2+\Gamma_Z^2 M_Z^2}\Big],$$

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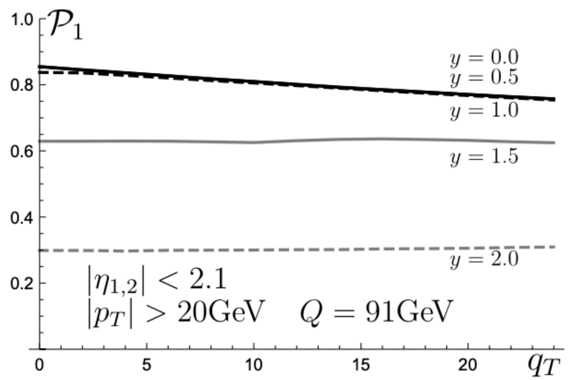

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Hadronic function

$$W_{GG'}^{\mu\nu} = \frac{1}{2\pi}\sum_f 2(g_R^G g_R^{G'} + g_L^G g_L^{G'})\Big[-g_T^{\mu\nu} W_{f_1 f_1}^f(Q,|q_T|,x_1,x_2)\Big]$$

$$W_{f_1 f_1}^f = |C_V(-Q^2,\mu^2)|^2\int_0^\infty db\, b J_0(bq_T) f_{1,f\leftarrow h_1}(x_1,b;\mu,\zeta_1) f_{1,\bar{f}\leftarrow h_2}(x_2,b;\mu,\zeta_2)$$