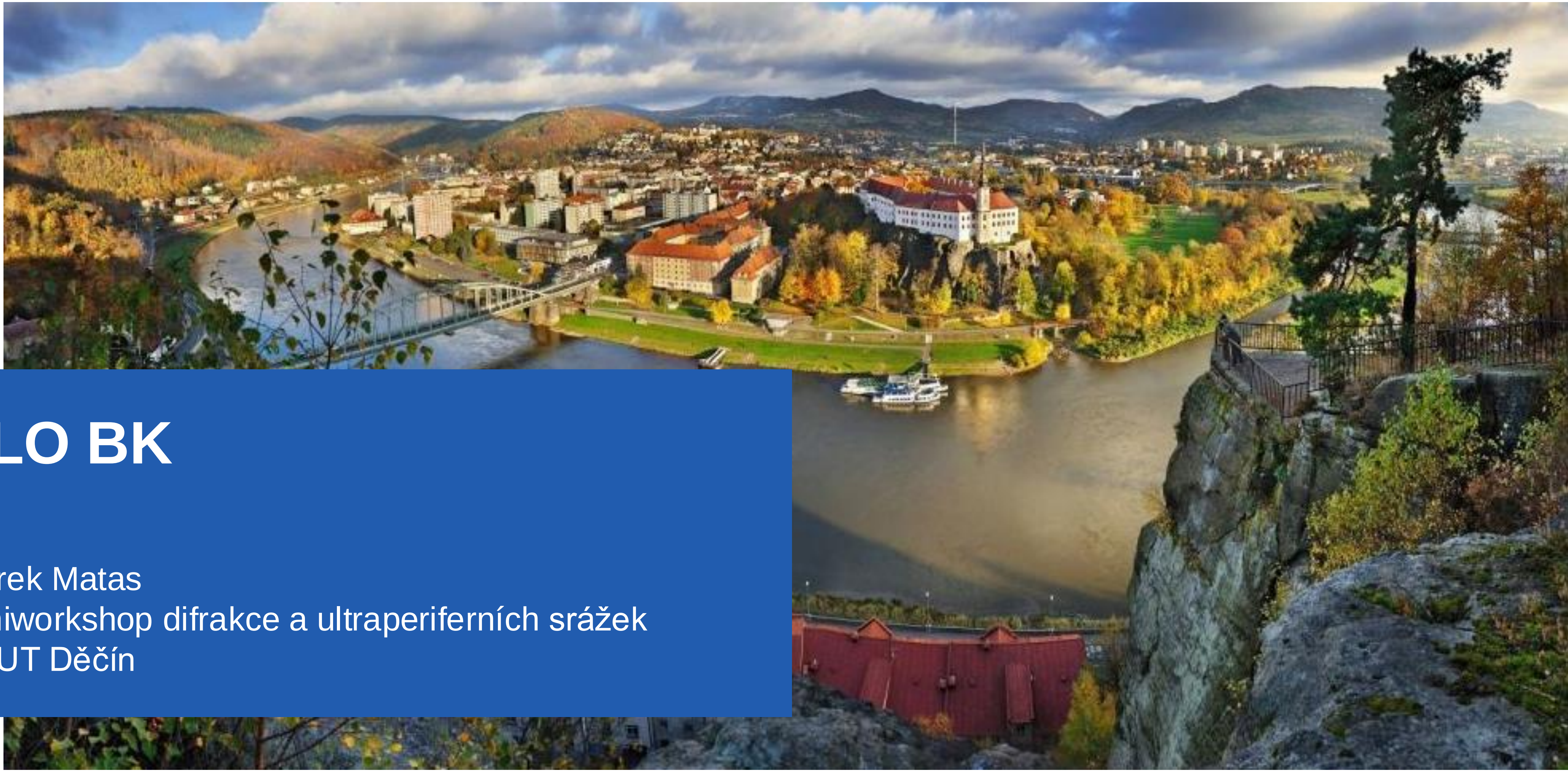


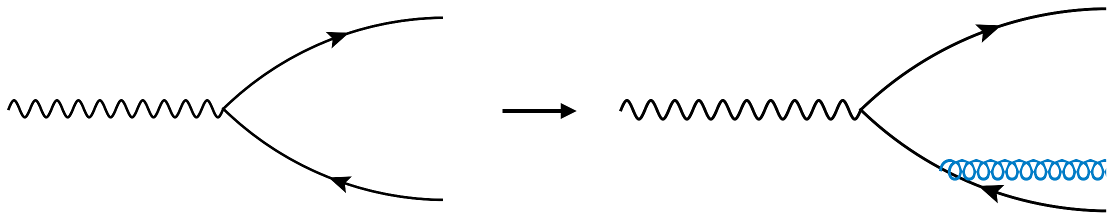
NLO BK

Marek Matas
Miniworkshop difrakce a ultraperiferních srážek
ČVUT Děčín

THE BK EQUATION

NLO BK IN PICTURES

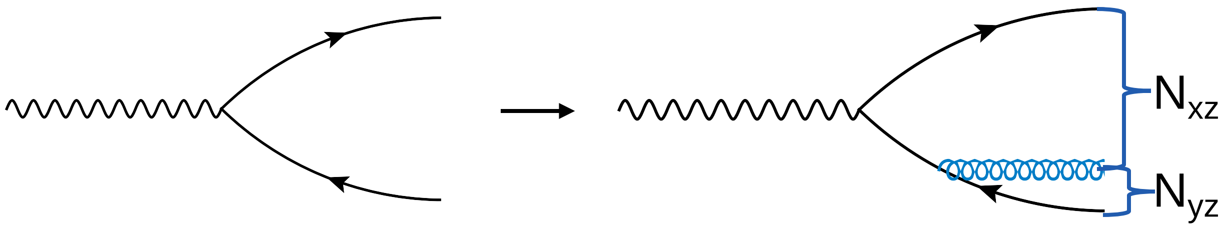
$$\frac{\partial N(r_{xy}, Y)}{\partial Y} = \int \mathrm{d}\vec{r}_{xz}\, K(r_{xy}, r_{xz}, r_{zy}) \left[N(r_{xz}, Y) + N(r_{zy}, Y) - N(r_{xy}, Y) - N(r_{xz}, Y)\, N(r_{zy}, Y) \right]$$



Add a bit of energy

NLO BK IN PICTURES

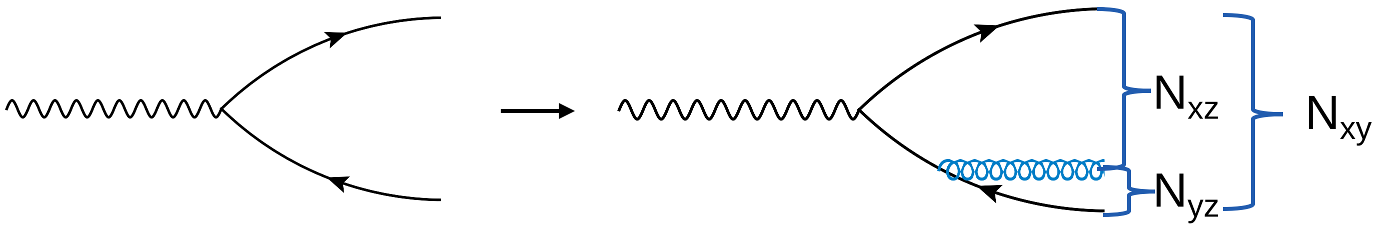
$$\frac{\partial N(r_{xy},Y)}{\partial Y} = \int \mathrm{d}\vec{r}_{xz}\, K(r_{xy},r_{xz},r_{zy})\left[N(r_{xz},Y)+N(r_{zy},Y)-N(r_{xy},Y)-N(r_{xz},Y)\,N(r_{zy},Y)\right]$$



Add a bit of energy

NLO BK IN PICTURES

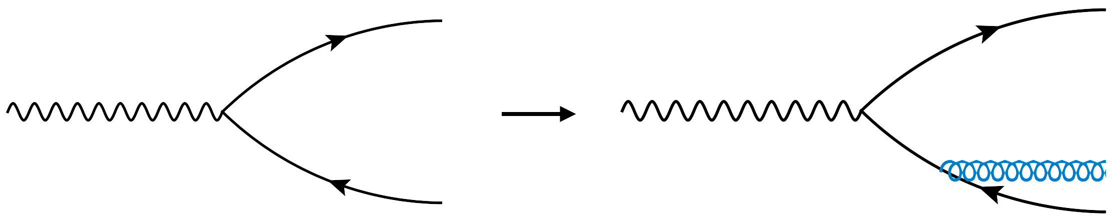
$$\frac{\partial N(r_{xy}, Y)}{\partial Y} = \int \mathrm{d}\vec{r}_{xz}\, K(r_{xy}, r_{xz}, r_{zy}) \left[N(r_{xz}, Y) + N(r_{zy}, Y) - N(r_{xy}, Y) - N(r_{xz}, Y)\, N(r_{zy}, Y) \right]$$



Add a bit of energy

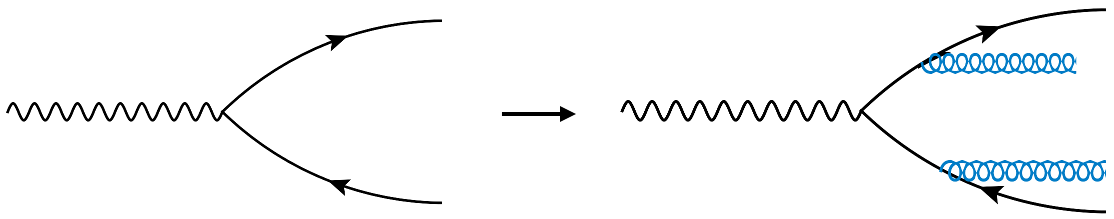
NLO

NLO BK IN PICTURES



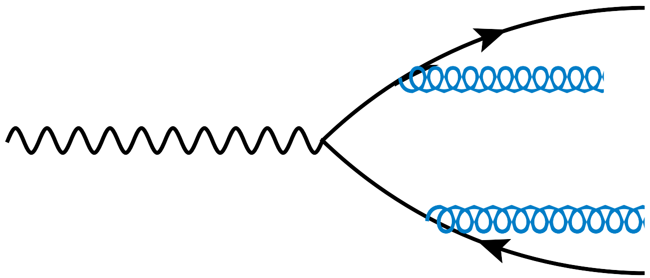
Add a bit of energy

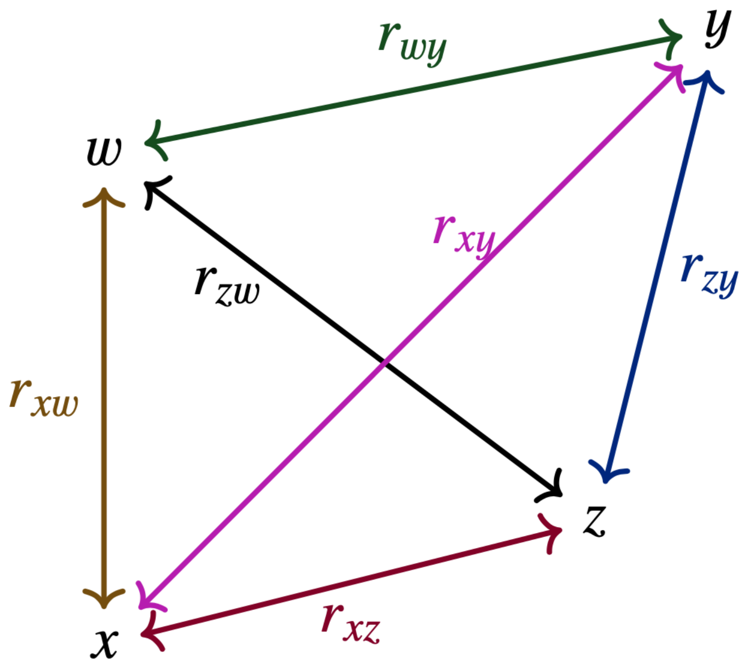
NLO BK IN PICTURES



Add a bit of energy

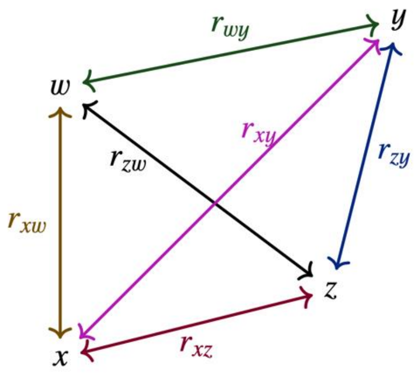
NLO BK IN PICTURES





THE MATH

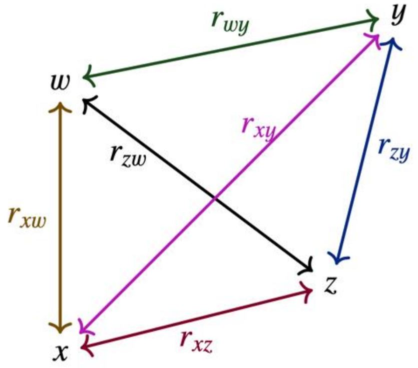
NLO BK IN WRITING



$$
\begin{aligned}
\partial_Y N(r_{xy}) \quad = \quad & \int \mathrm{d}^2 z K_\mathrm{a} \left[N(r_{xz}) + N(r_{zy}) - N(r_{xy}) - N(r_{xz})N(r_{zy}) \right] \\
+ \quad & \int \mathrm{d}^2 z \, \mathrm{d}^2 w \, K_\mathrm{b} \Big[N(r_{wy}) + N(r_{zw}) - N(r_{zy}) - N(r_{xz})N(r_{zw}) - N(r_{xz})N(r_{wy}) - \\
& \quad -N(r_{zw})N(r_{wy}) + N(r_{xz})N(r_{zy}) + N(r_{xz})N(r_{zw})N(r_{wy}) \Big] \\
+ \quad & \int \mathrm{d}^2 z \, \mathrm{d}^2 w \, K_\mathrm{f} \Big[N(r_{xw}) - N(r_{xz}) - N(r_{zy})N(r_{xw}) + N(r_{xz})N(r_{zy}) \Big].
\end{aligned}
$$

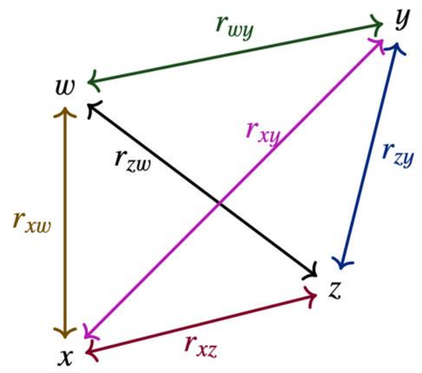
Fakulta jaderná a fyzikálně inženýrská

NLO BK IN WRITING



$$
\begin{aligned}
\partial_Y N(r_{xy}) \quad = \quad & \int d^2 z K_{\rm a} \left[N(r_{xz}) + N(r_{zy}) - N(r_{xy}) - N(r_{xz}) N(r_{zy}) \right] \\
+ \quad & \int d^2 z \, d^2 w \, K_{\rm b} \Big[N(r_{wy}) + N(r_{zw}) - N(r_{zy}) - N(r_{xz}) N(r_{zw}) - N(r_{xz}) N(r_{wy}) - \\
& \quad -N(r_{zw}) N(r_{wy}) + N(r_{xz}) N(r_{zy}) + N(r_{xz}) N(r_{zw}) N(r_{wy}) \Big] \\
+ \quad & \int d^2 z \, d^2 w \, K_{\rm f} \Big[N(r_{xw}) - N(r_{xz}) - N(r_{zy}) N(r_{xw}) + N(r_{xz}) N(r_{zy}) \Big].
\end{aligned}
$$

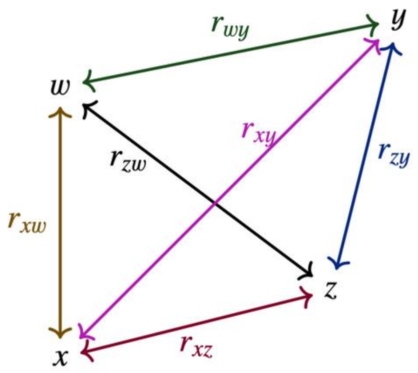
NLO BK IN WRITING



$$
\begin{aligned}
\partial_Y N(r_{xy}) \;=\; & \int d^2 z K_a \left[N(r_{xz}) + N(r_{zy}) - N(r_{xy}) - N(r_{xz})N(r_{zy})\right] \\
+ & \int d^2 z\, d^2 w\, K_b \Big[N(r_{wy}) + N(r_{zw}) - N(r_{zy}) - N(r_{xz})N(r_{zw}) - N(r_{xz})N(r_{wy}) - \\
& \quad -N(r_{zw})N(r_{wy}) + N(r_{xz})N(r_{zy}) + N(r_{xz})N(r_{zw})N(r_{wy})\Big] \\
+ & \int d^2 z\, d^2 w\, K_f \Big[N(r_{xw}) - N(r_{xz}) - N(r_{zy})N(r_{xw}) + N(r_{xz})N(r_{zy})\Big].
\end{aligned}
$$

$$
K_f = \frac{\alpha_S^2 n_f N_C^2}{8\pi^4}\left(\frac{2}{r_{zw}^4} - \frac{r_{xw}^2 r_{zy}^2 + r_{wy}^2 r_{xz}^2 - r_{xy}^2 r_{zw}^2}{r_{zw}^4 (r_{xz}^2 r_{wy}^2 - r_{xw}^2 r_{zy}^2)} \ln \frac{r_{xz}^2 r_{wy}^2}{r_{xw}^2 r_{zy}^2}\right)
$$

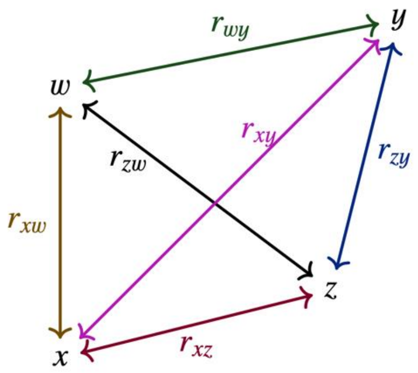
NLO BK IN WRITING



$$
\begin{aligned}
\partial_Y N(r_{xy}) \quad = \quad & \int \mathrm{d}^2 z K_\mathrm{a} \left[N(r_{xz}) + N(r_{zy}) - N(r_{xy}) - N(r_{xz})N(r_{zy}) \right] \\
+ \quad & \int \mathrm{d}^2 z \, \mathrm{d}^2 w \, K_\mathrm{b} \Big[N(r_{wy}) + N(r_{zw}) - N(r_{zy}) - N(r_{xz})N(r_{zw}) - N(r_{xz})N(r_{wy}) - \\
& \quad -N(r_{zw})N(r_{wy}) + N(r_{xz})N(r_{zy}) + N(r_{xz})N(r_{zw})N(r_{wy}) \Big] \\
+ \quad & \int \mathrm{d}^2 z \, \mathrm{d}^2 w \, K_\mathrm{f} \Big[N(r_{xw}) - N(r_{xz}) - N(r_{zy})N(r_{xw}) + N(r_{xz})N(r_{zy}) \Big].
\end{aligned}
$$

$$
K_\mathrm{b} = \frac{\alpha_S^2 N_\mathrm{c}^2}{8\pi^4} \left(-\frac{2}{r_{zw}^4} + \left[\frac{r_{xz}^2 r_{wy}^2 + r_{xw}^2 r_{zy}^2 - 4 r^2 r_{zw}^2}{r_{zw}^4 (r_{xz}^2 r_{wy}^2 - r_{xw}^2 r_{zy}^2)} + \frac{r_{xy}^4}{r_{xz}^2 r_{wy}^2 (r_{xz}^2 r_{wy}^2 - r_{xw}^2 r_{zy}^2)} + \frac{r_{xy}^2}{r_{xz}^2 r_{wy}^2 r_{zw}^2} \right] \ln \frac{r_{xz}^2 r_{wy}^2}{r_{xw}^2 r_{zy}^2} \right)
$$

NLO BK IN WRITING



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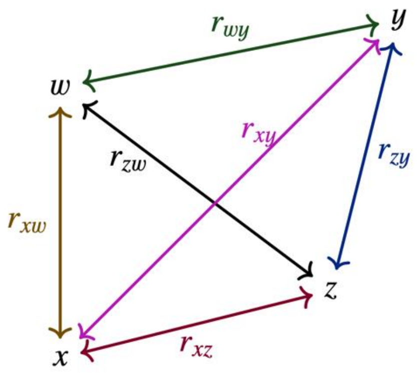
\begin{aligned}
\partial_Y N(r_{xy}) \quad = \quad & \int \mathrm{d}^2 z K_\mathrm{a} \left[N(r_{xz}) + N(r_{zy}) - N(r_{xy}) - N(r_{xz})N(r_{zy}) \right] \\
+ \quad & \int \mathrm{d}^2 z\, \mathrm{d}^2 w\, K_\mathrm{b} \Big[N(r_{wy}) + N(r_{zw}) - N(r_{zy}) - N(r_{xz})N(r_{zw}) - N(r_{xz})N(r_{wy}) - \\
& \qquad -N(r_{zw})N(r_{wy}) + N(r_{xz})N(r_{zy}) + N(r_{xz})N(r_{zw})N(r_{wy}) \Big] \\
+ \quad & \int \mathrm{d}^2 z\, \mathrm{d}^2 w\, K_\mathrm{f} \Big[N(r_{xw}) - N(r_{xz}) - N(r_{zy})N(r_{xw}) + N(r_{xz})N(r_{zy}) \Big].
\end{aligned}
$$

$$
K_1(r_{xy}, r_{xz}, r_{zy}) = K_\mathrm{rc} K_\mathrm{STL} K_\mathrm{DLA} - K_\mathrm{sub} + K_\mathrm{fin}
$$

NLO BK IN WRITING

$$K_{\rm rc}(r_{xy}, r_{xz}, r_{zy}) = \frac{\bar{\alpha}_S(r_{xy})}{2\pi}\left[\frac{r_{\rm xy}^2}{r_{\rm xz}^2 r_{\rm zy}^2} + \frac{1}{r_{\rm xz}^2}\left(\frac{\alpha_S(r_{xz})}{\alpha_S(r_{zy})} - 1\right) + \frac{1}{r_{\rm zy}^2}\left(\frac{\alpha_S(r_{zy})}{\alpha_S(r_{xz})} - 1\right)\right]$$

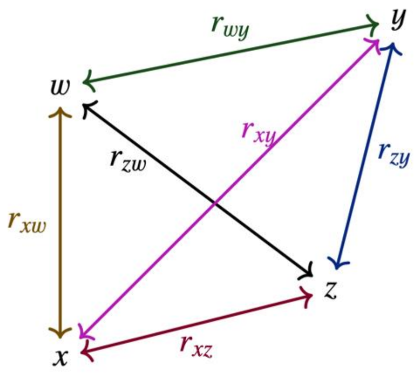


$$K_1(r_{xy}, r_{xz}, r_{zy}) = K_{\rm rc} K_{\rm STL} K_{\rm DLA} - K_{\rm sub} + K_{\rm fin}$$

NLO BK IN WRITING

$$K_{rc}(r_{xy}, r_{xz}, r_{zy}) = \frac{\bar{\alpha}_S(r_{xy})}{2\pi}\left[\frac{r_{xy}^2}{r_{xz}^2 r_{zy}^2} + \frac{1}{r_{xz}^2}\left(\frac{\alpha_S(r_{xz})}{\alpha_S(r_{zy})} - 1\right) + \frac{1}{r_{zy}^2}\left(\frac{\alpha_S(r_{zy})}{\alpha_S(r_{xz})} - 1\right)\right]$$

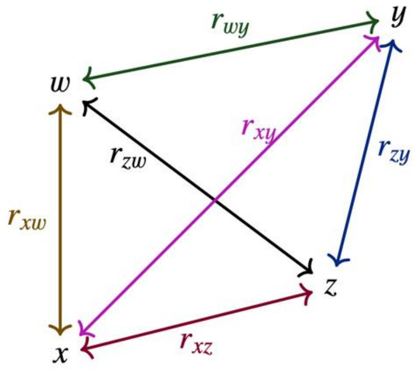
$$K_{STL} = \exp\left[-\bar{\alpha}_S A_1 \left| \ln\left(\frac{C_{sub} r_{xy}}{\min\{r_{xz}, r_{zy}\}}\right)\right|\right]$$



$$K_1(r_{xy}, r_{xz}, r_{zy}) = K_{rc} K_{STL} K_{DLA} - K_{sub} + K_{fin}$$

NLO BK IN WRITING

$$K_{rc}(r_{xy}, r_{xz}, r_{zy}) = \frac{\bar{\alpha}_S(r_{xy})}{2\pi}\left[\frac{r_{xy}^2}{r_{xz}^2 r_{zy}^2} + \frac{1}{r_{xz}^2}\left(\frac{\alpha_S(r_{xz})}{\alpha_S(r_{zy})} - 1\right) + \frac{1}{r_{zy}^2}\left(\frac{\alpha_S(r_{zy})}{\alpha_S(r_{xz})} - 1\right)\right]$$



$$K_{STL} = \exp\left[-\bar{\alpha}_S A_1 \left|\ln\left(\frac{C_{sub} r_{xy}}{\min\{r_{xz}, r_{zy}\}}\right)\right|\right]$$

$$K_{DLA}(\rho) = \frac{J_1\left(2\sqrt{\bar{\alpha}_S \rho^2}\right)}{\sqrt{\bar{\alpha}_S \rho^2}} \qquad \rho = \sqrt{L_{r_{xz} r_{xy}} L_{r_{zy} r_{xy}}}; \qquad L_{r_i r_{xy}} = \ln\left(\frac{r_i^2}{r_{xy}^2}\right)$$

$$K_1(r_{xy}, r_{xz}, r_{zy}) = K_{rc} K_{STL} K_{DLA} - K_{sub} + K_{fin}$$

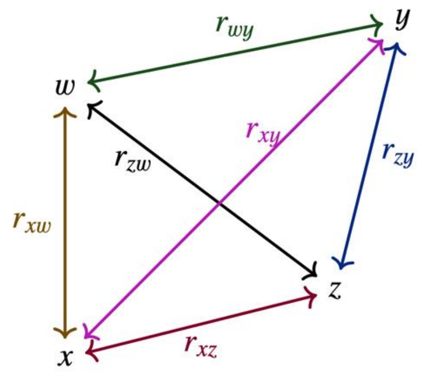
NLO BK IN WRITING

$$K_{\rm rc}(r_{xy}, r_{xz}, r_{zy}) = \frac{\bar{\alpha}_S(r_{xy})}{2\pi}\left[\frac{r_{\rm xy}^2}{r_{\rm xz}^2 r_{\rm zy}^2} + \frac{1}{r_{\rm xz}^2}\left(\frac{\alpha_S(r_{xz})}{\alpha_S(r_{zy})} - 1\right) + \frac{1}{r_{\rm zy}^2}\left(\frac{\alpha_S(r_{zy})}{\alpha_S(r_{xz})} - 1\right)\right]$$

$$K_{\rm STL} = \exp\left[-\bar{\alpha}_S A_1 \left|\ln\left(\frac{C_{\rm sub} r_{xy}}{\min\{r_{xz}, r_{zy}\}}\right)\right|\right]$$

$$K_{\rm DLA}(\rho) = \frac{J_1\left(2\sqrt{\bar{\alpha}_S \rho^2}\right)}{\sqrt{\bar{\alpha}_S \rho^2}} \qquad \rho = \sqrt{L_{r_{xz}r_{xy}} L_{r_{zy}r_{xy}}}; \qquad L_{r_i r_{xy}} = \ln\left(\frac{r_i^2}{r_{xy}^2}\right)$$

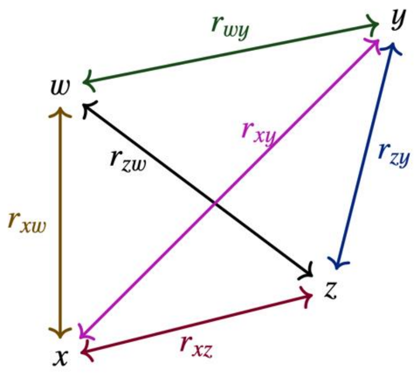
$$K_{\rm sub} = \frac{\bar{\alpha}_S}{2\pi}\left[-\bar{\alpha}_S A_1 \left|\ln\left(\frac{C_{\rm sub} r_{xy}}{\min\{r_{xz}^2, r_{zy}^2\}}\right)\right|\right] \frac{r_{xy}^2}{r_{xz}^2 r_{zy}^2}$$



$$K_1(r_{xy}, r_{xz}, r_{zy}) = K_{\rm rc} K_{\rm STL} K_{\rm DLA} - \boxed{K_{\rm sub}} + K_{\rm fin}$$

NLO BK IN WRITING

$$K_{\mathrm{rc}}(r_{xy}, r_{xz}, r_{zy}) = \frac{\bar{\alpha}_S(r_{xy})}{2\pi}\left[\frac{r_{\mathrm{xy}}^2}{r_{\mathrm{xz}}^2 r_{\mathrm{zy}}^2} + \frac{1}{r_{\mathrm{xz}}^2}\left(\frac{\alpha_S(r_{xz})}{\alpha_S(r_{zy})} - 1\right) + \frac{1}{r_{\mathrm{zy}}^2}\left(\frac{\alpha_S(r_{zy})}{\alpha_S(r_{xz})} - 1\right)\right]$$



$$K_{\mathrm{STL}} = \exp\left[-\bar{\alpha}_S A_1 \left|\ln\left(\frac{C_{\mathrm{sub}} r_{xy}}{\min\left\{r_{xz}, r_{zy}\right\}}\right)\right|\right]$$

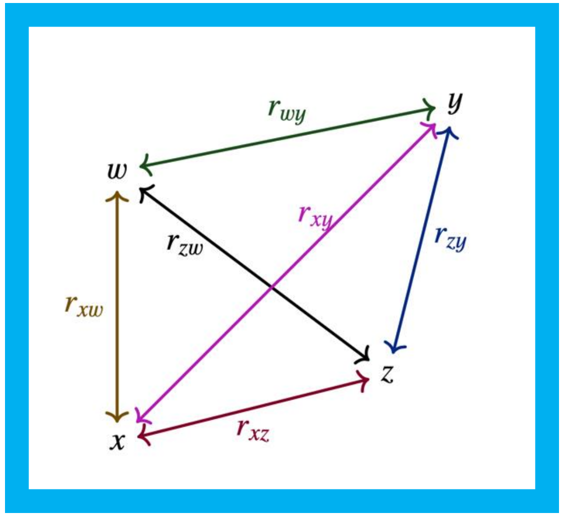
$$K_{\mathrm{DLA}}(\rho) = \frac{J_1\left(2\sqrt{\bar{\alpha}_S \rho^2}\right)}{\sqrt{\bar{\alpha}_S \rho^2}} \qquad \rho = \sqrt{L_{r_{xz} r_{xy}} L_{r_{zy} r_{xy}}}; \qquad L_{r_i r_{xy}} = \ln\left(\frac{r_i^2}{r_{xy}^2}\right)$$

$$K_{\mathrm{sub}} = \frac{\bar{\alpha}_S}{2\pi}\left[-\bar{\alpha}_S A_1 \left|\ln\left(\frac{C_{\mathrm{sub}} r_{xy}}{\min\left\{r_{xz}^2, r_{zy}^2\right\}}\right)\right|\right] \frac{r_{xy}^2}{r_{xz}^2 r_{zy}^2} \qquad K_{\mathrm{fin}} = \frac{\bar{\alpha}_S^2}{8\pi} \frac{r_{xy}^2}{r_{xz}^2 r_{zy}^2}\left[\frac{67}{9} - \frac{\pi^2}{3} - \frac{10}{9}\frac{n_{\mathrm{f}}}{N_{\mathrm{c}}}\right]$$

$$K_1(r_{xy}, r_{xz}, r_{zy}) = K_{\mathrm{rc}} K_{\mathrm{STL}} K_{\mathrm{DLA}} - K_{\mathrm{sub}} + K_{\mathrm{fin}}$$

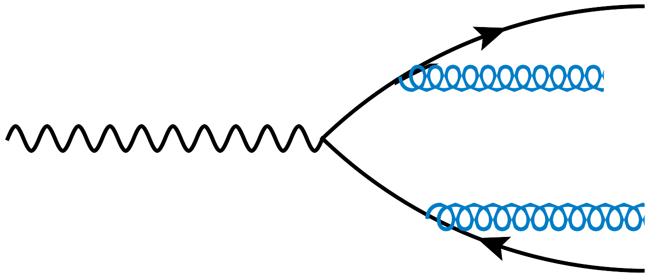
NLO BK IN WRITING

$$\begin{aligned}\partial_Y N(r_{xy}) &= \int d^2z K_a \left[N(r_{xz}) + N(r_{zy}) - N(r_{xy}) - N(r_{xz})N(r_{zy})\right] \\ &+ \int d^2z\, d^2w\, K_b\Big[N(r_{wy}) + N(r_{zw}) - N(r_{zy}) - N(r_{xz})N(r_{zw}) - N(r_{xz})N(r_{wy}) - \\ &\quad -N(r_{zw})N(r_{wy}) + N(r_{xz})N(r_{zy}) + N(r_{xz})N(r_{zw})N(r_{wy})\Big] \\ &+ \int d^2z\, d^2w\, K_f\Big[N(r_{xw}) - N(r_{xz}) - N(r_{zy})N(r_{xw}) + N(r_{xz})N(r_{zy})\Big].\end{aligned}$$



$$K_{STL} = \exp\left[-\bar{\alpha}_S A_1 \left| \ln\left(\frac{C_{sub} r_{xy}}{\min\{r_{xz}, r_{zy}\}}\right)\right|\right] \qquad K_{DLA}(\rho) = \frac{J_1\left(2\sqrt{\bar{\alpha}_S \rho^2}\right)}{\sqrt{\bar{\alpha}_S \rho^2}} \qquad \rho = \sqrt{L_{r_{xz}r_{xy}} L_{r_{zy}r_{xy}}}; \qquad L_{r_i r_{xy}} = \ln\left(\frac{r_i^2}{r_{xy}^2}\right)$$

$$K_{rc}(r_{xy}, r_{xz}, r_{zy}) = \frac{\bar{\alpha}_S(r_{xy})}{2\pi}\left[\frac{r_{xy}^2}{r_{xz}^2 r_{zy}^2} + \frac{1}{r_{xz}^2}\left(\frac{\alpha_S(r_{xz})}{\alpha_S(r_{zy})} - 1\right) + \frac{1}{r_{zy}^2}\left(\frac{\alpha_S(r_{zy})}{\alpha_S(r_{xz})} - 1\right)\right] \qquad K_{fin} = \frac{\bar{\alpha}_S^2}{8\pi}\frac{r_{xy}^2}{r_{xz}^2 r_{zy}^2}\left[\frac{67}{9} - \frac{\pi^2}{3} - \frac{10}{9}\frac{n_f}{N_c}\right]$$



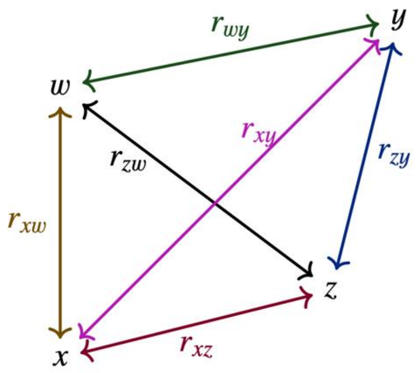
$$K_{sub} = \frac{\bar{\alpha}_S}{2\pi}\left[-\bar{\alpha}_S A_1 \left|\ln\left(\frac{C_{sub} r_{xy}}{\min\{r_{xz}^2, r_{zy}^2\}}\right)\right|\right]\frac{r_{xy}^2}{r_{xz}^2 r_{zy}^2} \qquad K_f = \frac{\alpha_S^2 n_f N_C^2}{8\pi^4}\left(\frac{2}{r_{zw}^4} - \frac{r_{xw}^2 r_{zy}^2 + r_{wy}^2 r_{xz}^2 - r_{xy}^2 r_{zw}^2}{r_{zw}^4(r_{xz}^2 r_{wy}^2 - r_{xw}^2 r_{zy}^2)}\ln\frac{r_{xz}^2 r_{wy}^2}{r_{xw}^2 r_{zy}^2}\right)$$

$$K_b = \frac{\alpha_S^2 N_c^2}{8\pi^4}\left(-\frac{2}{r_{zw}^4} + \left[\frac{r_{xz}^2 r_{wy}^2 + r_{xw}^2 r_{zy}^2 - 4r^2 r_{zw}^2}{r_{zw}^4(r_{xz}^2 r_{wy}^2 - r_{xw}^2 r_{zy}^2)} + \frac{r_{xy}^4}{r_{xz}^2 r_{wy}^2(r_{xz}^2 r_{wy}^2 - r_{xw}^2 r_{zy}^2)} + \frac{r_{xy}^2}{r_{xz}^2 r_{wy}^2 r_{zw}^2}\right]\ln\frac{r_{xz}^2 r_{wy}^2}{r_{xw}^2 r_{zy}^2}\right)$$

$$K_1(r_{xy}, r_{xz}, r_{zy}) = K_{rc} K_{STL} K_{DLA} - K_{sub} + K_{fin}$$

THE PROBLEMS

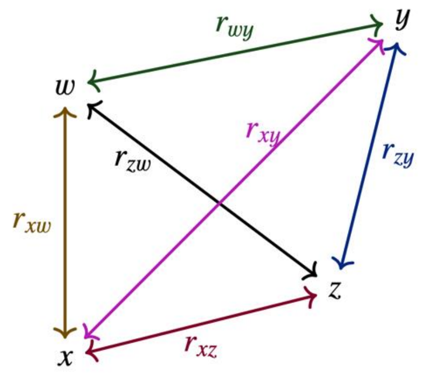
NLO BK IN WRITING



$$
\begin{aligned}
\partial_Y N(r_{xy}) \quad = \quad & \int \mathrm{d}^2 z K_{\rm a} \left[N(r_{xz}) + N(r_{zy}) - N(r_{xy}) - N(r_{xz}) N(r_{zy}) \right] \\
+ \quad & \int \mathrm{d}^2 z \, \mathrm{d}^2 w \, K_{\rm b} \Big[N(r_{wy}) + N(r_{zw}) - N(r_{zy}) - N(r_{xz}) N(r_{zw}) - N(r_{xz}) N(r_{wy}) - \\
& \quad -N(r_{zw}) N(r_{wy}) + N(r_{xz}) N(r_{zy}) + N(r_{xz}) N(r_{zw}) N(r_{wy}) \Big] \\
+ \quad & \int \mathrm{d}^2 z \, \mathrm{d}^2 w \, K_{\rm f} \Big[N(r_{xw}) - N(r_{xz}) - N(r_{zy}) N(r_{xw}) + N(r_{xz}) N(r_{zy}) \Big].
\end{aligned}
$$

NLO BK IN WRITING

This takes ages to calculate

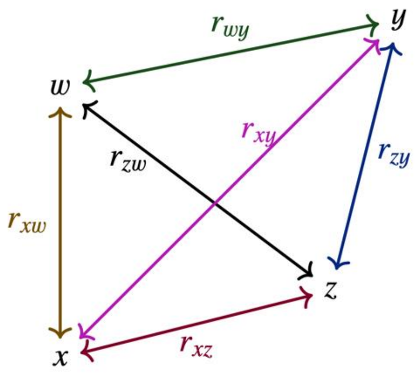


$$
\begin{aligned}
\partial_Y N(r_{xy}) \quad = \quad & \int \mathrm{d}^2 z K_\mathrm{a} \left[N(r_{xz}) + N(r_{zy}) - N(r_{xy}) - N(r_{xz})N(r_{zy})\right] \\
+ \quad & \int \mathrm{d}^2 z\, \mathrm{d}^2 w\, K_\mathrm{b} \Big[N(r_{wy}) + N(r_{zw}) - N(r_{zy}) - N(r_{xz})N(r_{zw}) - N(r_{xz})N(r_{wy}) - \\
& \quad -N(r_{zw})N(r_{wy}) + N(r_{xz})N(r_{zy}) + N(r_{xz})N(r_{zw})N(r_{wy})\Big] \\
+ \quad & \int \mathrm{d}^2 z\, \mathrm{d}^2 w\, K_\mathrm{f} \left[N(r_{xw}) - N(r_{xz}) - N(r_{zy})N(r_{xw}) + N(r_{xz})N(r_{zy})\right].
\end{aligned}
$$

nsteps in r * nsteps in angle ~ 4000x slower

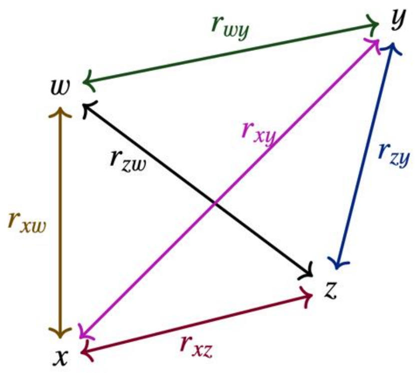
NLO BK IN WRITING

$$K_{\mathrm{f}} = \frac{\alpha_S^2 n_f N_C^2}{8\pi^4}\left(\frac{2}{r_{zw}^4} - \frac{r_{xw}^2 r_{zy}^2 + r_{wy}^2 r_{xz}^2 - r_{xy}^2 r_{zw}^2}{r_{zw}^4 (r_{xz}^2 r_{wy}^2 - r_{xw}^2 r_{zy}^2)} \ln \frac{r_{xz}^2 r_{wy}^2}{r_{xw}^2 r_{zy}^2}\right)$$



This is OK!

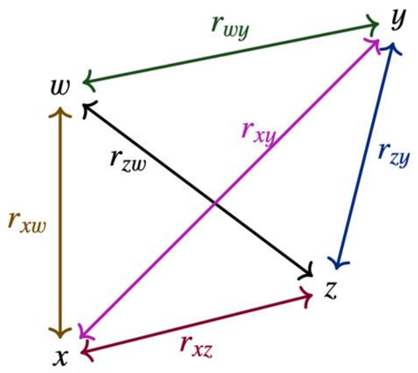
NLO BK IN WRITING



$$K_{\mathrm{f}} = \frac{\alpha_S^2 n_f N_C^2}{8\pi^4}\left(\frac{2}{r_{zw}^4} - \frac{r_{xw}^2 r_{zy}^2 + r_{wy}^2 r_{xz}^2 - r_{xy}^2 r_{zw}^2}{r_{zw}^4\left(r_{xz}^2 r_{wy}^2 - r_{xw}^2 r_{zy}^2\right)} \ln \frac{r_{xz}^2 r_{wy}^2}{r_{xw}^2 r_{zy}^2}\right)$$

This is not

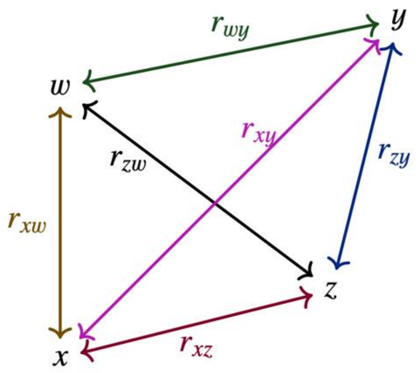
NLO BK IN WRITING



$$K_{\mathrm{f}} = \frac{\alpha_S^2 n_f N_C^2}{8\pi^4}\left(\frac{2}{r_{zw}^4} - \frac{r_{xw}^2 r_{zy}^2 + r_{wy}^2 r_{xz}^2 - r_{xy}^2 r_{zw}^2}{r_{zw}^4 (r_{xz}^2 r_{wy}^2 - r_{xw}^2 r_{zy}^2)} \ln \frac{r_{xz}^2 r_{wy}^2}{r_{xw}^2 r_{zy}^2}\right)$$

This also not

NLO BK IN WRITING



$$K_{\mathrm{f}} = \frac{\alpha_S^2 n_f N_C^2}{8\pi^4}\left(\frac{2}{r_{zw}^4} - \frac{r_{xw}^2 r_{zy}^2 + r_{wy}^2 r_{xz}^2 - r_{xy}^2 r_{zw}^2}{r_{zw}^4 (r_{xz}^2 r_{wy}^2 - r_{xw}^2 r_{zy}^2)} \ln \frac{r_{xz}^2 r_{wy}^2}{r_{xw}^2 r_{zy}^2}\right)$$

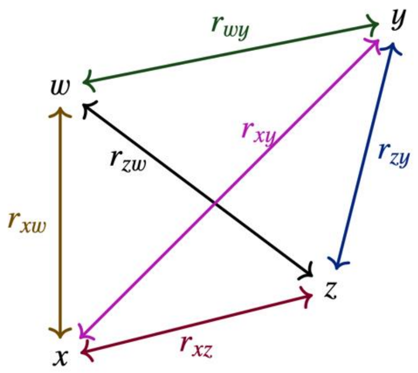
$$r_{xw}^2 r_{zy}^2 = r_{xz}^2 r_{wy}^2$$

$$r_{xw}^2 r_{zy}^2$$

NLO BK IN WRITING

This does not work ☺

$$\frac{\ldots N_C^2}{8\pi^4}\left(\frac{2}{r_{zw}^4} - \frac{r_{xw}^2 r_{zy}^2 + r_{wy}^2 r_{xz}^2 - r_{xy}^2 r_{zw}^2}{r_{zw}^4\,(r_{xz}^2 r_{wy}^2 - r_{xw}^2 r_{zy}^2)} \ln \frac{r_{xz}^2 r_{wy}^2}{r_{xw}^2 r_{zy}^2}\right)$$



$$r_{xw}^2 r_{zy}^2 = r_{xz}^2 r_{wy}^2$$

$$r_{xw}^2 r_{zy}^2$$

So we cut out the problematic part of phase space and check for stability

THE RESULTS

RESULTS

+

+

+

+

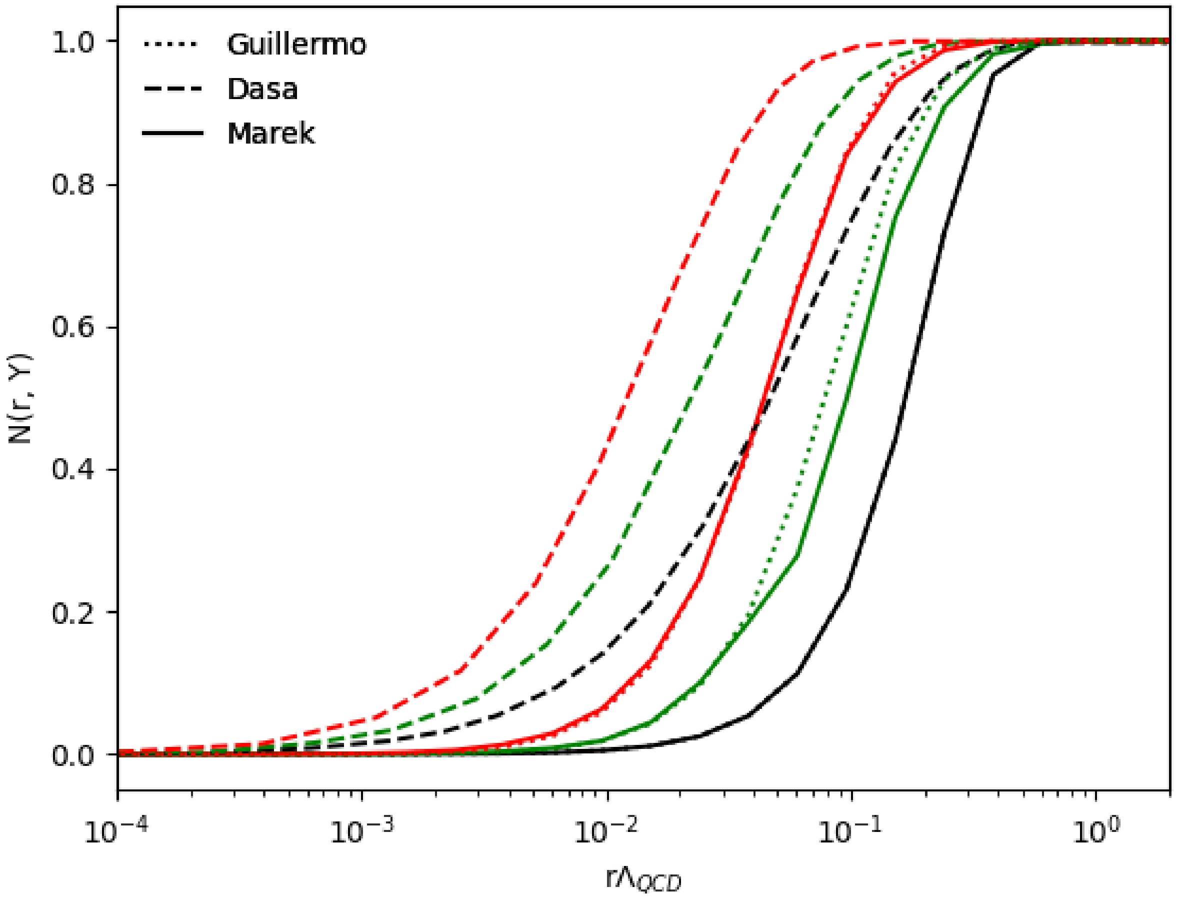
RESULTS

+

+ +

+

=


Guillermo
Dasa
Marek
1.0
0.8
0.6
0.4
0.2
0.0
N(r, Y)
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
$r\Lambda_{QCD}$

STAY TUNED FOR OBSERVABLES

!


That's all Folks!