Erratum: Quark sivers function at small $x$: spin-dependent odderon and the sub-eikonal evolution

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Abstract: We provide corrections to equations (2.28), (2.29), and (2.31) in the original manuscript. These changes remove multiple typos, but do not affect the main results and conclusions.

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1 Section 2.2 corrections

Five equations in the original manuscript [1] are to be replaced. All of the corrections are simply minus signs or insertions of factors of 2 or $\gamma^5$. First, equation (2.29) should be replaced by

$$\mathcal{O}_{\chi'\chi}^{\text{pol}}(z_2,-z_1;\bar{z}_2,\bar{z}_1) = -\frac{g^2}{8s} \pi^+ t^b \psi_{\beta}(z_2,-z_1) \left[ 1 - \frac{i \pi^+ \partial z_2}{2s} \right] U_{\bar{z}_1}^{b\alpha}[z_2,-z_1] \delta^2(\bar{z}_2-z_1) \left[ 1 - \frac{i \pi^+ \partial z_1}{2s} \right]$$

$$\times \left\{ \gamma^+\delta_{\chi'\chi'} - \gamma^+\gamma^5\delta_{\chi'\chi'} - \frac{2m\pi^+}{s} [\delta_{\chi'\chi'} - \delta_{\chi'\chi'}i\gamma^1\gamma^2] \right\}$$

$$\times \frac{p_i^+}{2s} \left[ -\chi'(1-\gamma^5)^5 (i\gamma^2 + \gamma^4) [iS\partial z_2 + S\bar{S} \partial z_2] + (1+\gamma^5) (i\gamma^2 + \gamma^4) [iS\partial z_2 - S\bar{S} \partial z_2] + (1-i\gamma^1\gamma^2) [iS\partial z_1 + S\bar{S} \partial z_1] \right]$$

Equation (2.29) should be replaced by

$$\mathcal{O}_{\chi'\chi}^{\text{pol}}(z_2,-z_1;\bar{z}_2,\bar{z}_1) = -\frac{g^2}{8s} \pi^+ t^b \psi_{\beta}(z_2,-z_1) \left[ 1 - \frac{i \pi^+ \partial z_2}{2s} \right] U_{\bar{z}_1}^{b\alpha}[z_2,-z_1] \delta^2(\bar{z}_2-z_1)$$

$$\times \left[ \delta''^{\alpha''\alpha''} - \frac{i \pi^+ \partial z_2^{''\alpha''}}{2s} \right] \left\{ \gamma^+\delta_{\chi'\chi'} + \gamma^5\delta_{\chi'\chi'} - \gamma^5\gamma^1\gamma^2 - \frac{2m\pi^+}{s} [\delta_{\chi'\chi'} - \delta_{\chi'\chi'}i\gamma^1\gamma^2] \right\}$$

$$\times \frac{p_i^+}{2s} \left[ -\chi'(1-\gamma^5)^5 (i\gamma^2 + \gamma^4) [iS\partial z_2 + S\bar{S} \partial z_2] + (1+\gamma^5) (i\gamma^2 + \gamma^4) [iS\partial z_2 - S\bar{S} \partial z_2] + (1-i\gamma^1\gamma^2) [iS\partial z_1 + S\bar{S} \partial z_1] \right]$$

Equation (2.29) should be replaced by

$$\mathcal{O}_{\chi'\chi}^{\text{pol}}(z_2,-z_1;\bar{z}_2,\bar{z}_1) = -\frac{g^2}{8s} \pi^+ t^b \psi_{\beta}(z_2,-z_1) \left[ 1 - \frac{i \pi^+ \partial z_2}{2s} \right] U_{\bar{z}_1}^{b\alpha}[z_2,-z_1] \delta^2(\bar{z}_2-z_1)$$

$$\times \left[ \delta''^{\alpha''\alpha''} - \frac{i \pi^+ \partial z_2^{''\alpha''}}{2s} \right] \left\{ \gamma^+\delta_{\chi'\chi'} + \gamma^5\delta_{\chi'\chi'} - \gamma^5\gamma^1\gamma^2 - \frac{2m\pi^+}{s} [\delta_{\chi'\chi'} - \delta_{\chi'\chi'}i\gamma^1\gamma^2] \right\}$$

The text immediately below equation (2.29) should be changed to say “with $D_{z_1}^i = \partial_{z_1}^i - igA_i(z_1^1, z_1)$ and $D_{\bar{z}_2}^i = \bar{\partial}_{\bar{z}_2}^i + igA_i(z_2^1, \bar{z}_2)$ acting on . . .”

The adjoint covariant derivatives in the rest of the same paragraph should be changed to $\partial_{\bar{z}_2}^{ab} = \bar{\partial}_{\bar{z}_2}^{ab} - gf^{abc}A_c(z_2^1, \bar{z}_2)$, $\partial_{z_1}^{ab} = \partial_{z_1}^{ab} + gf^{abc}A_c(z_1^1, z_1)$ and $\partial_{\bar{z}_2} = \bar{\partial}_{\bar{z}_2} + gf^{abc}A_c$. 
Equation (2.31) should be replaced by
\[
\mathcal{O}^{\text{pol}}_{\chi, \chi'}(z_2, z_1; \bar{z}_2, \bar{z}_1) = \frac{g^2 p^+}{8s} i \delta_{\beta}^{\gamma} (z_2, \bar{z}_2) \left[ \frac{d^\gamma}{2s} - \frac{ip^+ (\mathcal{P}^\gamma)^-}{2s} \right] U^{\gamma a'}_{z_2} |z_2, z_1\rangle \delta^2(z_2 - z_1) \tag{2.31}
\]
\[
\times \left\{ \delta^{\alpha a'} - \frac{ip^+ (\mathcal{P}^a)^-}{2s} \right\} \left[ \gamma^+ \delta^{\alpha a'} \delta^{\gamma b'} - \frac{2mp^+}{s} \delta^{\alpha a'} \delta^{b' b'} \right]
\]
\[
- \delta_{\chi, \chi'} \left[ \gamma^+ \gamma^\delta \delta^{\alpha a'} \delta^{b' b'} - \frac{2mp^+}{s} \gamma^\delta \delta^{\alpha a'} \delta^{b' b'} \right]
\]
\[
- \frac{p^+}{s} \left( (\gamma^2 - \gamma \gamma^2) \right) \left[ i [\mathbf{S} \cdot \mathbf{D}_{z_2} - \mathbf{S} \times \mathbf{D}_{\bar{z}_2}] (1 - i \gamma \gamma^2 + 2i \gamma \gamma^2) \right] \}
\]
\[
\times \bar{\psi}_{\alpha}(z_1, z_1) t^a + \mathcal{O}\left( \frac{1}{s^3} \right).
\]

The covariant derivative definitions below equation (2.35) should be changed to \( \mathcal{D}^{ab} = \mathcal{Q}^{ab} - g f^{acb} A^c \) and \( \bar{\mathcal{D}}^{ab} = \bar{\mathcal{Q}}^{ab} + g f^{acb} A^c \).

Equation (2.36) should be replaced by
\[
V_{\chi, \chi'}^{\text{pol}}(z_2, z_1) = \frac{ig^2 (p^+)^2}{16s^2} \int_{\infty}^{-\infty} \delta^2(\bar{z}_2 - z_3) \left\{ \delta^{\alpha a'} - \frac{ip^+ (\mathcal{P}^a)^-}{2s} \right\} \left[ \frac{d^\gamma}{2s} - \frac{ip^+ (\mathcal{P}^\gamma)^-}{2s} \right] U^{\gamma a'}_{z_2} |z_2, z_1\rangle \delta^2(z_2 - z_1) \tag{2.36}
\]
\[
\times \left\{ \delta^{\alpha a'} - \frac{ip^+ (\mathcal{P}^a)^-}{2s} \right\} \left[ \gamma^+ \gamma^\delta \delta^{\alpha a'} \delta^{b' b'} - \frac{2mp^+}{s} \gamma^\delta \delta^{\alpha a'} \delta^{b' b'} \right] \}
\]
\[
- \delta_{\chi, \chi'} \left[ \gamma^+ \gamma^\delta \delta^{\alpha a'} \delta^{b' b'} - \frac{2mp^+}{s} \gamma^\delta \delta^{\alpha a'} \delta^{b' b'} \right]
\]
\[
+ \chi \delta_{\chi, \chi'} \left[ \gamma^+ \gamma^\delta \delta^{\alpha a'} \delta^{b' b'} - \frac{2mp^+}{s} \gamma^\delta \delta^{\alpha a'} \delta^{b' b'} \right] \}
\]
\[
\times \bar{\psi}_{\alpha}(z_1, z_1) t^a + \mathcal{O}\left( \frac{1}{s^3} \right).
\]

Finally, equation (2.37) should be replaced by
\[
V_{\chi, \chi'}^{\text{pol}}(z_2, z_1) = \frac{ig^2 (p^+)^2}{16s^2} \int_{\infty}^{-\infty} \delta^2(\bar{z}_2 - z_3) \left\{ \delta^{\alpha a'} - \frac{ip^+ (\mathcal{P}^a)^-}{2s} \right\} \left[ \frac{d^\gamma}{2s} - \frac{ip^+ (\mathcal{P}^\gamma)^-}{2s} \right] U^{\gamma a'}_{z_2} |z_2, z_1\rangle \delta^2(z_2 - z_1) \tag{2.37}
\]
\[
\times \left\{ \delta^{\alpha a'} - \frac{ip^+ (\mathcal{P}^a)^-}{2s} \right\} \left[ \gamma^+ \gamma^\delta \delta^{\alpha a'} \delta^{b' b'} - \frac{2mp^+}{s} \gamma^\delta \delta^{\alpha a'} \delta^{b' b'} \right] \}
\]
\[
- \delta_{\chi, \chi'} \left[ \gamma^+ \gamma^\delta \delta^{\alpha a'} \delta^{b' b'} - \frac{2mp^+}{s} \gamma^\delta \delta^{\alpha a'} \delta^{b' b'} \right]
\]
\[
+ \chi \delta_{\chi, \chi'} \left[ \gamma^+ \gamma^\delta \delta^{\alpha a'} \delta^{b' b'} - \frac{2mp^+}{s} \gamma^\delta \delta^{\alpha a'} \delta^{b' b'} \right] \}
\]
\[
\times \bar{\psi}_{\alpha}(z_1, z_1) t^a + \mathcal{O}\left( \frac{1}{s^3} \right).
\]
The prefactor on the r.h.s. of equation (3.40) should be changed from $4N_c$ to $8N_c$.

None of these replacements change the main results and conclusions of the original manuscript.

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**References**

[1] Y.V. Kovchegov and M.G. Santiago, *Quark sivers function at small $x$: spin-dependent odderon and the sub-eikonal evolution*, *JHEP* **11** (2021) 200 [arXiv:2108.03667] [esPIRE].