PSALTer results panel

Wave operator and propagator

	$1^{+}\mathcal{A}_s{}^{\perp}{}_{\alpha\beta}$	$1^{-}h^{\perp}{}_{\alpha}$	$1^{-}\mathcal{A}_s{}^{\perp t}{}_{\alpha}$	$1^{-}\mathcal{A}_s{}^{\parallel t}{}_{\alpha}$	$1^{-}\mathcal{A}_s{}^{\perp h}{}_{\alpha}$	$1^{-}\mathcal{A}_s{}^{\parallel h}{}_{\alpha}$
$1^{+}\mathcal{A}_s{}^{\perp}\dagger^{\alpha\beta}$	$\frac{1}{4}(-2k^2 h_9 + a_0)$	0	0	0	0	0
$1^{-}h^{\perp}\dagger^{\alpha}$	0		$-\frac{i k a_0}{4\sqrt{6}}$	$\frac{1}{4} i \sqrt{\frac{5}{6}} k a_0$	$\frac{i k a_0}{8\sqrt{3}}$	$-\frac{i k a_0}{4\sqrt{6}}$
$1^{-}\mathcal{A}_s{}^{\perp t}\dagger^{\alpha}$	0	$\frac{i k a_0}{4\sqrt{6}}$	$\frac{1}{6}(-k^2(h_{11}+h_7+h_9)-2a_0)$	$\frac{1}{6}\sqrt{5}(k^2(h_{12}+h_8-h_9)+a_0)$	$\frac{2k^2(h_{11}+h_7+h_9)+a_0}{12\sqrt{2}}$	$\frac{1}{12}(k^2(h_{12}-2(h_8+2h_9))+a_0)$
$1^{-}\mathcal{A}_s{}^{\parallel t}\dagger^{\alpha}$	0	$-\frac{1}{4} i \sqrt{\frac{5}{6}} k a_0$	$\frac{1}{6}\sqrt{5}(k^2(h_{12}+h_8-h_9)+a_0)$	$\frac{1}{6}(-5k^2(h_{11}+h_7+h_9)+2a_0)$	$\frac{1}{12}\sqrt{\frac{5}{2}}(-2k^2(h_{12}+h_8-h_9)+a_0)$	$\frac{1}{12}\sqrt{5}(-k^2(h_{11}-2h_7+4h_9)+a_0)$
$1^{-}\mathcal{A}_s{}^{\perp h}\dagger^{\alpha}$	0	$-\frac{i k a_0}{8\sqrt{3}}$	$\frac{2k^2(h_{11}+h_7+h_9)+a_0}{12\sqrt{2}}$	$\frac{1}{12}\sqrt{\frac{5}{2}}(-2k^2(h_{12}+h_8-h_9)+a_0)$	$\frac{1}{12}(-k^2(h_{11}+h_7+h_9)+a_0)$	$\frac{k^2(-h_{12}+2h_8+4h_9)-4a_0}{12\sqrt{2}}$
$1^{-}\mathcal{A}_s{}^{\parallel h}\dagger^{\alpha}$	0	$\frac{i k a_0}{4\sqrt{6}}$	$\frac{1}{12}(k^2(h_{12}-2(h_8+2h_9))+a_0)$	$\frac{1}{12}\sqrt{5}(-k^2(h_{11}-2h_7+4h_9)+a_0)$	$\frac{k^2(-h_{12}+2h_8+4h_9)-4a_0}{12\sqrt{2}}$	$\frac{1}{12}(k^2(4h_{11}-2(h_7+4h_9))-a_0)$

	$0^{+}h^{\perp}$	$0^{+}h^{\parallel}$	$0^{+}\mathcal{A}_s{}^{\perp t}$	$0^{+}\mathcal{A}_s{}^{\parallel}$	$0^{+}\mathcal{A}_s{}^{\perp h}$
$0^{+}h^{\perp}\dagger$	0	0	0	$\frac{i k a_0}{4}$	$\frac{i k a_0}{8\sqrt{2}}$
$0^{+}h^{\parallel}\dagger$	0	0	0	$-\frac{i k a_0}{4\sqrt{3}}$	$\frac{5 i k a_0}{8\sqrt{6}}$
$0^{+}\mathcal{A}_s{}^{\perp t}\dagger$	0	0	0	$\frac{a_0}{2}$	$\frac{a_0}{4\sqrt{2}}$
$0^{+}\mathcal{A}_s{}^{\parallel}\dagger$	$-\frac{1}{4} i k a_0$	$\frac{i k a_0}{4\sqrt{3}}$	$\frac{a_0}{2}$	$-\frac{2}{3}k^2(h_{11}+h_{12}+h_7+h_8)$	$\frac{2k^2(-2h_{11}-2h_{12}+h_7+h_8)+3a_0}{12\sqrt{2}}$
$0^{+}\mathcal{A}_s{}^{\perp h}\dagger$	$-\frac{i k a_0}{8\sqrt{2}}$	$-\frac{5 i k a_0}{8\sqrt{6}}$	$\frac{a_0}{4\sqrt{2}}$	$\frac{2k^2(-2h_{11}-2h_{12}+h_7+h_8)+3a_0}{12\sqrt{2}}$	$\frac{1}{12}(k^2(8h_{11}+8h_{12}-7(h_7+h_8))-3a_0)$

	$0^{+}\mathcal{T}^{\perp}$	$0^{+}\mathcal{T}^{\parallel}$	$0^{+}\mathcal{W}_s{}^{\perp t}$	$0^{+}\mathcal{W}_s{}^{\parallel}$	$0^{+}\mathcal{W}_s{}^{\perp h}$
$0^{+}\mathcal{T}^{\perp}\dagger$	$\frac{4k^2(6k^2(h_{11}+h_{12}+h_7+h_8)-a_0)}{3(4+k^2)^2 a_0^2}$	$-\frac{8k^2(h_{11}+h_{12})}{\sqrt{3}(4+k^2)a_0^2}$	$\frac{8 i k(6k^2(h_{11}+h_{12}+h_7+h_8)-a_0)}{3(4+k^2)^2 a_0^2}$	$\frac{10 i k}{3(4+k^2)a_0}$	$\frac{4 i \sqrt{2} k}{3(4+k^2)a_0}$
$0^{+}\mathcal{T}^{\parallel}\dagger$	$-\frac{8k^2(h_{11}+h_{12})}{\sqrt{3}(4+k^2)a_0^2}$	$\frac{4(2k^2(-h_{11}-h_{12}+h_7+h_8)+a_0)}{k^2 a_0^2}$	$-\frac{16 i k(h_{11}+h_{12})}{\sqrt{3}(4+k^2)a_0^2}$	$-\frac{2 i}{\sqrt{3} k a_0}$	$\frac{4 i \sqrt{\frac{2}{3}}}{k a_0}$
$0^{+}\mathcal{W}_s{}^{\perp t}\dagger$	$-\frac{8 i k(6k^2(h_{11}+h_{12}+h_7+h_8)-a_0)}{3(4+k^2)^2 a_0^2}$	$\frac{16 i k(h_{11}+h_{12})}{\sqrt{3}(4+k^2)a_0^2}$	$\frac{16(6k^2(h_{11}+h_{12}+h_7+h_8)-a_0)}{3(4+k^2)^2 a_0^2}$	$\frac{20}{3(4+k^2)a_0}$	$\frac{8\sqrt{2}}{3(4+k^2)a_0}$
$0^{+}\mathcal{W}_s{}^{\parallel}\dagger$	$-\frac{10 i k}{12a_0+3k^2a_0}$	$\frac{2 i}{\sqrt{3} k a_0}$	$\frac{20}{12a_0+3k^2a_0}$	0	0
$0^{+}\mathcal{W}_s{}^{\perp h}\dagger$	$-\frac{4 i \sqrt{2} k}{12a_0+3k^2a_0}$	$-\frac{4 i \sqrt{\frac{2}{3}}}{k a_0}$	$\frac{8\sqrt{2}}{12a_0+3k^2a_0}$	0	0

	$3^{-}\mathcal{W}_s{}^{\parallel}{}_{\alpha\beta\chi}$
$3^{-}\mathcal{W}_s{}^{\parallel}\dagger^{\alpha\beta\chi}$	$-\frac{2}{a_0}$

	$3^{-}\mathcal{A}_s{}^{\parallel}{}_{\alpha\beta\chi}$
$3^{-}\mathcal{A}_s{}^{\parallel}\dagger^{\alpha\beta\chi}$	$-\frac{a_0}{2}$

	$2^{+}\mathcal{T}^{\parallel}{}_{\alpha\beta}$	$2^{+}\mathcal{W}_s{}^{\parallel}{}_{\alpha\beta}$	$2^{+}\mathcal{W}_s{}^{\perp}{}_{\alpha\beta}$	$2^{-}\mathcal{W}_s{}^{\parallel}{}_{\alpha\beta\chi}$
$2^{+}\mathcal{T}^{\parallel}\dagger^{\alpha\beta}$	$-\frac{2(k^4(h_{11}+h_{12})^2+4k^2(h_{11}+h_{12}-h_7-h_8)a_0+4a_0^2)}{k^2 a_0^3}$	$\frac{4 i(k^2(h_{11}+h_{12})+a_0)}{\sqrt{3} k a_0^2}$	$-\frac{2 i \sqrt{\frac{2}{3}}(k^2(h_{11}+h_{12})+4a_0)}{k a_0^2}$	0
$2^{+}\mathcal{W}_s{}^{\parallel}\dagger^{\alpha\beta}$	$-\frac{4 i(k^2(h_{11}+h_{12})+a_0)}{\sqrt{3} k a_0^2}$	$-\frac{8}{3a_0}$	$\frac{4\sqrt{2}}{3a_0}$	0
$2^{+}\mathcal{W}_s{}^{\perp}\dagger^{\alpha\beta}$	$\frac{2 i \sqrt{\frac{2}{3}}(k^2(h_{11}+h_{12})+4a_0)}{k a_0^2}$	$\frac{4\sqrt{2}}{3a_0}$	$-\frac{4}{3a_0}$	0
$2^{-}\mathcal{W}_s{}^{\parallel}\dagger^{\alpha\beta\chi}$	0	0	0	$\frac{4}{a_0}$

$$
\begin{aligned}
S == \iiiint \Big(\tfrac{1}{4}\big(&-2a_0\, \mathcal{A}_{\alpha\chi\beta}\mathcal{A}^{\alpha\beta\chi} + 2a_0\, \mathcal{A}^{\alpha\ \beta}_{\ \alpha}\mathcal{A}^{\chi}{}_{\beta\chi} + 4\mathcal{A}^{\alpha\beta\chi}\mathcal{W}_{\alpha\beta\chi} + \\
&4\mathcal{T}^{\alpha\beta} h_{\alpha\beta} + 2a_0\, h^{\alpha\beta}\partial_\beta\mathcal{A}_{\alpha\ \chi}^{\ \chi} - 2a_0\, h^{\alpha\beta}\partial_\chi\mathcal{A}_{\alpha\ \beta}^{\ \chi} - \\
&a_0\, h^{\alpha}{}_{\alpha}\partial_\chi\mathcal{A}^{\beta\ \chi}_{\ \beta} + a_0\, h^{\alpha}{}_{\alpha}\partial_\chi\mathcal{A}^{\beta\chi}{}_{\beta} - 2h_8\,\partial_\beta\mathcal{A}_{\chi\ \delta}^{\ \delta}\partial^\chi\mathcal{A}^{\alpha\ \beta}_{\ \alpha} - \\
&2h_{12}\,\partial_\beta\mathcal{A}^{\delta}{}_{\chi\delta}\partial^\chi\mathcal{A}^{\alpha\ \beta}_{\ \alpha} - 2h_7\,\partial_\chi\mathcal{A}_{\beta\ \delta}^{\ \delta}\partial^\chi\mathcal{A}^{\alpha\ \beta}_{\ \alpha} - \\
&2h_{11}\,\partial_\chi\mathcal{A}^{\delta}{}_{\beta\delta}\partial^\chi\mathcal{A}^{\alpha\ \beta}_{\ \alpha} + 2h_9\,\partial_\beta\mathcal{A}^{\delta}{}_{\chi\delta}\partial^\chi\mathcal{A}^{\alpha\beta}{}_{\alpha} - \\
&2h_9\,\partial_\chi\mathcal{A}^{\delta}{}_{\beta\delta}\partial^\chi\mathcal{A}^{\alpha\beta}{}_{\alpha} - 2h_7\,\partial_\beta\mathcal{A}^{\alpha\beta\chi}\partial_\delta\mathcal{A}_{\alpha\ \chi}^{\ \delta} - \\
&2h_8\,\partial_\beta\mathcal{A}^{\alpha\beta\chi}\partial_\delta\mathcal{A}_{\alpha\ \chi}^{\ \delta} + 2h_9\,\partial_\alpha\mathcal{A}^{\alpha\beta\chi}\partial_\delta\mathcal{A}_{\beta\chi}{}^{\delta} + \\
&2h_{12}\,\partial^\chi\mathcal{A}^{\alpha\ \beta}_{\ \alpha}\partial_\delta\mathcal{A}_{\beta\chi}{}^{\delta} - 4h_9\,\partial^\chi\mathcal{A}^{\alpha\beta}{}_{\alpha}\partial_\delta\mathcal{A}_{\beta\chi}{}^{\delta} - \\
&2h_{11}\,\partial_\alpha\mathcal{A}^{\alpha\beta\chi}\partial_\delta\mathcal{A}_{\beta\ \chi}^{\ \delta} - 2h_{12}\,\partial_\alpha\mathcal{A}^{\alpha\beta\chi}\partial_\delta\mathcal{A}_{\beta\ \chi}^{\ \delta} + \\
&4h_7\,\partial^\chi\mathcal{A}^{\alpha\ \beta}_{\ \alpha}\partial_\delta\mathcal{A}_{\beta\ \chi}^{\ \delta} + 4h_8\,\partial^\chi\mathcal{A}^{\alpha\ \beta}_{\ \alpha}\partial_\delta\mathcal{A}_{\beta\ \chi}^{\ \delta} + \\
&2h_{11}\,\partial^\chi\mathcal{A}^{\alpha\beta}{}_{\alpha}\partial_\delta\mathcal{A}_{\beta\ \chi}^{\ \delta} + 2h_{12}\,\partial^\chi\mathcal{A}^{\alpha\beta}{}_{\alpha}\partial_\delta\mathcal{A}_{\beta\ \chi}^{\ \delta} - \\
&2h_9\,\partial_\alpha\mathcal{A}^{\alpha\beta\chi}\partial_\delta\mathcal{A}_{\chi\ \beta}^{\ \delta} + 2h_{11}\,\partial^\chi\mathcal{A}^{\alpha\ \beta}_{\ \alpha}\partial_\delta\mathcal{A}_{\chi\ \beta}^{\ \delta} + \\
&4h_9\,\partial^\chi\mathcal{A}^{\alpha\beta}{}_{\alpha}\partial_\delta\mathcal{A}_{\chi\ \beta}^{\ \delta}\big)\Big)[t,x,y,z]\,dz\,dy\,dx\,dt
\end{aligned}
$$

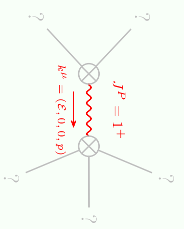
	$2^{+}h^{\parallel}{}_{\alpha\beta}$	$2^{+}\mathcal{A}_s{}^{\parallel}{}_{\alpha\beta}$	$2^{+}\mathcal{A}_s{}^{\perp}{}_{\alpha\beta}$	$2^{-}\mathcal{A}_s{}^{\parallel}{}_{\alpha\beta\chi}$
$2^{+}h^{\parallel}\dagger^{\alpha\beta}$	0	$-\frac{i k a_0}{4\sqrt{3}}$	$-\frac{i k a_0}{2\sqrt{6}}$	0
$2^{+}\mathcal{A}_s{}^{\parallel}\dagger^{\alpha\beta}$	$\frac{i k a_0}{4\sqrt{3}}$	$\frac{1}{6}(-k^2(h_{11}+h_{12}+h_7+h_8)-3a_0)$	$-\frac{k^2(h_{11}+h_{12}+4(h_7+h_8))}{12\sqrt{2}}$	0
$2^{+}\mathcal{A}_s{}^{\perp}\dagger^{\alpha\beta}$	$\frac{i k a_0}{2\sqrt{6}}$	$-\frac{k^2(h_{11}+h_{12}+4(h_7+h_8))}{12\sqrt{2}}$	$\frac{1}{6}k^2(h_{11}+h_{12}-2(h_7+h_8))+\frac{a_0}{4}$	0
$2^{-}\mathcal{A}_s{}^{\parallel}\dagger^{\alpha\beta\chi}$	0	0	0	$\frac{a_0}{4}$

Spin-parity form	Covariant form	Multiplicities
$k\, 0^{+}\mathcal{W}_s{}^{\perp t} + 2 i\, 0^{+}\mathcal{T}^{\perp} == 0$ 2	$\partial_\beta\partial_\alpha\mathcal{T}^{\alpha\beta} == \partial_\chi\partial_\beta\partial_\alpha\mathcal{W}^{\alpha\beta\chi}$	1
$2k\, 1^{-}\mathcal{W}_s{}^{\perp h\,\alpha} + k\, 1^{-}\mathcal{W}_s{}^{\perp t\,\alpha} + 6 i\, 1^{-}\mathcal{T}^{\perp\,\alpha} == 0$ 2	$\partial_\chi\partial_\beta\partial^\alpha\mathcal{T}^{\beta\chi} + \partial_\delta\partial^\delta\partial_\chi\partial_\beta\mathcal{W}^{\beta\alpha\chi} == 2\partial_\chi\partial^\chi\partial_\beta\mathcal{T}^{\alpha\beta} + \partial_\delta\partial_\chi\partial_\beta\partial^\alpha\mathcal{W}^{\beta\chi\delta}$	3
Total expected gauge generators:		4

Massive and massless spectra

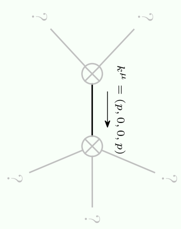
Massive particle

Pole residue:	$-\frac{2}{h_9} > 0$
Square mass:	$\frac{a_0}{2 h_9} > 0$
Spin:	1
Parity:	Even



Massless particle

Pole residue:	$-\frac{1}{a_0} > 0$
Polarisations:	2



Unitarity conditions

$(h_{11} \mid h_7) \in \mathbb{R} \;\&\&\; a_0 < 0 \;\&\&$

$\Big((h_8 < h_7 \;\&\&\; \Big(\Big(h_9 < \frac{1}{12}(-h_7+h_8) \;\&\&\; \frac{1}{2}(2h_{11}+h_7-h_8-12h_9) - \frac{1}{2}\sqrt{\frac{5}{3}}\sqrt{h_7^2-2h_7h_8+h_8^2+24h_7h_9-24h_8h_9+144h_9^2} \le h_{12} \le \frac{1}{2}(2h_{11}+h_7-h_8-12h_9) +$

$\frac{1}{2}\sqrt{\frac{5}{3}}\sqrt{h_7^2-2h_7h_8+h_8^2+24h_7h_9-24h_8h_9+144h_9^2}\Big) \;||$

$\Big(h_9 == \frac{1}{12}(-h_7+h_8) \;\&\&\; h_{12} == \frac{1}{2}(2h_{11}+h_7-h_8-12h_9) + \frac{1}{2}\sqrt{\frac{5}{3}}\sqrt{h_7^2-2h_7h_8+h_8^2+24h_7h_9-24h_8h_9+144h_9^2}\Big) \;||$

$\Big(\frac{1}{12}(-h_7+h_8) < h_9 < 0 \;\&\&\; \frac{1}{2}(2h_{11}+h_7-h_8-12h_9) - \frac{1}{2}\sqrt{\frac{5}{3}}\sqrt{h_7^2-2h_7h_8+h_8^2+24h_7h_9-24h_8h_9+144h_9^2} \le$

$h_{12} \le \frac{1}{2}(2h_{11}+h_7-h_8-12h_9) + \frac{1}{2}\sqrt{\frac{5}{3}}\sqrt{h_7^2-2h_7h_8+h_8^2+24h_7h_9-24h_8h_9+144h_9^2}\Big)\Big)\Big) \;||$

$\Big(h_8 == h_7 \;\&\&\; h_9 < 0 \;\&\&\; \Big(\frac{1}{2}(2h_{11}+h_7-h_8-12h_9) - \frac{1}{2}\sqrt{\frac{5}{3}}\sqrt{h_7^2-2h_7h_8+h_8^2+24h_7h_9-24h_8h_9+144h_9^2} \le h_{12} < h_{11} + 2\sqrt{2}\sqrt{h_7h_9-h_8h_9} \;||$

$h_{11} + 2\sqrt{2}\sqrt{h_7h_9-h_8h_9} < h_{12} \le \frac{1}{2}(2h_{11}+h_7-h_8-12h_9) + \frac{1}{2}\sqrt{\frac{5}{3}}\sqrt{h_7^2-2h_7h_8+h_8^2+24h_7h_9-24h_8h_9+144h_9^2}\Big)\Big) \;||$

$\Big(h_8 > h_7 \;\&\&\; \Big(\Big(h_9 < \frac{h_7-h_8}{3} - \frac{1}{4}\sqrt{\frac{5}{3}}\sqrt{h_7^2-2h_7h_8+h_8^2} \;\&\&\; \Big(\frac{1}{2}(2h_{11}+h_7-h_8-12h_9) - \frac{1}{2}\sqrt{\frac{5}{3}}\sqrt{h_7^2-2h_7h_8+h_8^2+24h_7h_9-24h_8h_9+144h_9^2} \le h_{12} < h_{11} -$

$2\sqrt{2}\sqrt{h_7h_9-h_8h_9} \;||\; h_{11} + 2\sqrt{2}\sqrt{h_7h_9-h_8h_9} < h_{12} \le \frac{1}{2}(2h_{11}+h_7-h_8-12h_9) + \frac{1}{2}\sqrt{\frac{5}{3}}\sqrt{h_7^2-2h_7h_8+h_8^2+24h_7h_9-24h_8h_9+144h_9^2}\Big)\Big) \;||$

$\Big(\frac{h_7-h_8}{3} - \frac{1}{4}\sqrt{\frac{5}{3}}\sqrt{h_7^2-2h_7h_8+h_8^2} \le h_9 < \frac{h_7-h_8}{3} + \frac{1}{4}\sqrt{\frac{5}{3}}\sqrt{h_7^2-2h_7h_8+h_8^2} \;\&\&\; h_{11} + 2\sqrt{2}\sqrt{h_7h_9-h_8h_9} < h_{12} \le$

$\frac{1}{2}(2h_{11}+h_7-h_8-12h_9) + \frac{1}{2}\sqrt{\frac{5}{3}}\sqrt{h_7^2-2h_7h_8+h_8^2+24h_7h_9-24h_8h_9+144h_9^2}\Big)\Big)\Big)\Big)$