Particle spectrograph

Wave operator and propagator

Spin-parity	form	Covariant	form	Multiplicities
0^+	τ ==0	$\partial_\beta\partial_\alpha\tau^{\alpha\beta}$ == 0		1
0^+	τ ==0	$\partial_\beta\partial_\alpha\tau^{\alpha\beta}$ == $\partial_\phi\partial^\beta\tau^\alpha{}_\alpha$		1
1^-	τ^α +2 i k σ^α == 0	$\partial_\chi\partial_\beta\partial^\alpha\tau^{\beta\chi}$ == $\partial_\chi\partial^\chi\partial_\beta\tau^{\alpha\beta}$ +2 $\partial_\delta\partial^\delta\partial_\chi\partial_\beta\sigma^{\alpha\beta\chi}$		3
1^-	τ^α == 0	$\partial_\chi\partial_\beta\partial^\alpha\tau^{\beta\chi}$ == $\partial_\chi\partial^\chi\partial_\beta\tau^{\beta\alpha}$		3
1^+	$\tau^{\alpha\beta}$ + i k $\sigma^{\alpha\beta}$ == 0	$\partial_\chi\partial^\alpha\tau^{\beta\chi}$ + $\partial_\chi\partial^\beta\tau^{\chi\alpha}$ + $\partial_\chi\partial^\chi\tau^{\alpha\beta}$ +2 $\partial_\delta\partial_\chi\partial^\alpha\sigma^{\beta\chi\delta}$ +2 $\partial_\delta\partial^\delta\partial_\chi\sigma^{\alpha\beta\chi}$ == $\partial_\chi\partial^\alpha\tau^{\chi\beta}$ + $\partial_\chi\partial^\beta\tau^{\alpha\chi}$ + $\partial_\chi\partial^\chi\tau^{\beta\alpha}$ +2 $\partial_\delta\partial_\chi\partial^\beta\sigma^{\alpha\chi\delta}$		3
2^+	$\tau^{\alpha\beta}$ -2 i k $\sigma^{\alpha\beta}$ == 0	-i (4 $\partial_\delta\partial_\chi\partial^\beta\partial^\alpha\tau^{\chi\delta}$ +2 $\partial_\delta\partial^\delta\partial^\beta\partial^\alpha\tau^\chi{}_\chi$ -3 $\partial_\delta\partial^\delta\partial_\chi\partial^\alpha\tau^{\beta\chi}$ -3 $\partial_\delta\partial^\delta\partial_\chi\partial^\beta\tau^{\chi\alpha}$ -3 $\partial_\delta\partial^\delta\partial_\chi\partial^\chi\tau^{\alpha\beta}$ +3 $\partial_\delta\partial^\delta\partial_\chi\partial^\chi\tau^{\beta\alpha}$ +4 i k $\partial_\epsilon\partial_\chi\partial^\beta\partial^\alpha\sigma^{\delta\epsilon}{}_\delta$ -6 i k $\partial_\epsilon\partial_\delta\partial_\chi\partial^\alpha\sigma^{\beta\delta\epsilon}$ -6 i k $\partial_\epsilon\partial_\delta\partial_\chi\partial^\beta\sigma^{\alpha\delta\epsilon}$ +2 $\eta^{\alpha\beta}$ $\partial_\epsilon\partial^\epsilon\partial_\delta\partial_\chi\tau^{\chi\delta}$ + 6 i k $\partial_\epsilon\partial^\epsilon\partial_\delta\partial_\chi\sigma^{\beta\delta\alpha}$ +6 i k $\partial_\epsilon\partial^\epsilon\partial_\delta\partial_\chi\sigma^{\alpha\delta\beta}$ -2 $\eta^{\alpha\beta}$ $\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\tau^\chi{}_\chi$ -4 i $\eta^{\alpha\beta}$ k $\partial_\phi\partial^\phi\partial_\epsilon\partial_\chi\sigma^{\delta\epsilon}{}_\delta$) == 0		5
Total expected gauge generators:				16

	$1^+\,\sigma_{\alpha\beta}$	$2^+\,\sigma_{\alpha\beta}$	$1^+\,\tau_{\alpha\beta}$	$1^-\,\sigma_\alpha$	$2^-\,\sigma_\alpha$	$1^-\,\tau_\alpha$	$2^-\,\tau_\alpha$
$1^+\,\sigma^\dagger{}^{\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	$-\frac{i\sqrt{2}\,k}{t_1+k^2 t_1}$	0	0	0	0
$2^+\,\sigma^\dagger{}^{\alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	$\frac{-2k^2(2r_3+r_5)+t_1}{(1+k^2)^2 t_1{}^2}$	$\frac{-2i k^2(2r_3+r_5)+i k \not{t}}{(1+k^2)^2 t_1{}^2}$	0	0	0	0
$1^+\,\tau^\dagger{}^{\alpha\beta}$	$\frac{i\sqrt{2}\,k}{t_1+k^2 t_1}$	$\frac{i(2k^3(2r_3+r_5)-k\not{t})}{(1+k^2)^2 t_1{}^2}$	$\frac{-2k^4(2r_3+r_5)+k^2 t_1}{(1+k^2)^2 t_1{}^2}$	0	0	0	0
$1^-\,\sigma^\dagger{}^{\alpha}$	0	0	0	$\frac{1}{k^2(2r_3+r_5)}$	$-\frac{1}{\sqrt{2}(k^2+2k^4)(2r_3+r_5)}$	0	$-\frac{i}{k(1+2k^2)(2r_3+r_5)}$
$2^-\,\sigma^\dagger{}^{\alpha}$	0	0	0	$-\frac{1}{\sqrt{2}(k^2+2k^4)(2r_3+r_5)}$	$\frac{6k^2(2r_3+r_5)+t_1}{2(k+2k^3)^2(2r_3+r_5)t_1}$	0	$\frac{i(6k^2(2r_3+r_5)+t_1)}{\sqrt{2}k(1+2k^2)^2(2r_3+r_5)t_1}$
$1^-\,\tau^\dagger{}^{\alpha}$	0	0	0	0	0 0		0
$2^-\,\tau^\dagger{}^{\alpha}$	0	0	0	$\frac{i}{k(1+2k^2)(2r_3+r_5)}$	$-\frac{i(6k^2(2r_3+r_5)+t_1)}{\sqrt{2}k(1+2k^2)^2(2r_3+r_5)t_1}$	0	$\frac{6k^2(2r_3+r_5)+t_1}{(1+2k^2)^2(2r_3+r_5)t_1}$

$$
\begin{aligned}
\mathcal{S} == \iiiint \Big(& f^{\alpha\beta}\ \tau_{\alpha\beta} + \mathcal{A}^{\alpha\beta\chi}\ \sigma_{\alpha\beta\chi} + \tfrac{1}{6} t_1 (2\,\mathcal{A}^{\alpha\prime}{}_{\alpha}\ \mathcal{A}_{\prime}{}^{\theta}{}_{\theta} - 4\ \mathcal{A}_{\alpha}{}^{\theta}{}_{\theta}\ \partial_\prime f^{\alpha\prime} + 4\ \mathcal{A}_{\prime}{}^{\theta}{}_{\theta}\ \partial^\prime f^{\alpha}{}_{\alpha} - 2\ \partial_\prime f^{\theta}{}_{\theta}\ \partial^\prime f^{\alpha}{}_{\alpha} - 2\ \partial_\prime f^{\alpha\prime} \\
& \partial_\theta f_{\alpha}{}^{\theta} + 4\ \partial^\prime f^{\alpha}{}_{\alpha}\ \partial_\theta f_{\prime}{}^{\theta} - 6\ \partial_\alpha f_{\prime\theta}\ \partial^\theta f^{\alpha\prime} - 3\ \partial_\alpha f_{\theta\prime}\ \partial^\theta f^{\alpha\prime} + 3\ \partial_\prime f_{\alpha\theta}\ \partial^\theta f^{\alpha\prime} + \\
& 3\ \partial_\theta f_{\alpha\prime}\ \partial^\theta f^{\alpha\prime} + 3\ \partial_\theta f_{\prime\alpha}\ \partial^\theta f^{\alpha\prime} + 6\ \mathcal{A}_{\alpha\theta\prime}\ (\mathcal{A}^{\alpha\prime\theta} + 2\ \partial^\theta f^{\alpha\prime})) + \\
& \tfrac{1}{3} r_2 (4\ \partial_\beta \mathcal{A}_{\alpha\prime\theta} - 2\ \partial_\beta \mathcal{A}_{\alpha\theta\prime} + 2\ \partial_\beta \mathcal{A}_{\prime\theta\alpha} - \partial_\prime \mathcal{A}_{\alpha\beta\theta} + \partial_\theta \mathcal{A}_{\alpha\beta\prime} - 2\ \partial_\theta \mathcal{A}_{\alpha\prime\beta})\, \partial^\theta \mathcal{A}^{\alpha\beta\prime} - \\
& 2 r_3 (\partial_\beta \mathcal{A}_{\prime}{}^{\theta}{}_{\theta}\ \partial^\prime \mathcal{A}^{\alpha\beta}{}_{\alpha} + \partial_\prime \mathcal{A}_{\beta}{}^{\theta}{}_{\theta}\ \partial^\prime \mathcal{A}^{\alpha\beta}{}_{\alpha} + \partial_\alpha \mathcal{A}^{\alpha\beta\prime}\ \partial_\theta \mathcal{A}_{\beta}{}^{\theta}{}_{\prime} - 2\ \partial^\prime \mathcal{A}^{\alpha\beta}{}_{\alpha}\ \partial_\theta \mathcal{A}_{\beta}{}^{\theta}{}_{\prime} + \\
& \partial_\alpha \mathcal{A}^{\alpha\beta\prime}\ \partial_\theta \mathcal{A}_{\prime}{}^{\theta}{}_{\beta} - 2\ \partial^\prime \mathcal{A}^{\alpha\beta}{}_{\alpha}\ \partial_\theta \mathcal{A}_{\prime}{}^{\theta}{}_{\beta} + 2\ \partial_\beta \mathcal{A}_{\prime\theta\alpha}\ \partial^\theta \mathcal{A}^{\alpha\beta\prime}) + r_5 (\partial_\prime \mathcal{A}_{\theta}{}^{\kappa}{}_{\kappa}\ \partial^\theta \mathcal{A}^{\alpha\prime}{}_{\alpha} - \\
& \partial_\theta \mathcal{A}_{\prime}{}^{\kappa}{}_{\kappa}\ \partial^\theta \mathcal{A}^{\alpha\prime}{}_{\alpha} - (\partial_\alpha \mathcal{A}^{\alpha\prime\theta} - 2\ \partial^\theta \mathcal{A}^{\alpha\prime}{}_{\alpha})(\partial_\kappa \mathcal{A}_{\prime}{}^{\kappa}{}_{\theta} - \partial_\kappa \mathcal{A}_{\theta}{}^{\kappa}{}_{\prime}))) \Big][t, x, y, z]\, d\!\!\!/\, z\ d\!\!\!/\, y\ d\!\!\!/\, x\ d\!\!\!/\, t
\end{aligned}
$$

	$1^+\,\mathcal{A}_{\alpha\beta}$	$2^+\,\mathcal{A}_{\alpha\beta}$	$1^+\,f_{\alpha\beta}$	$1^-\,\mathcal{A}_\alpha$	$2^-\,\mathcal{A}_\alpha$	$1^-\,f_\alpha$	$2^-\,f_\alpha$
$1^+\,\mathcal{A}^\dagger{}^{\alpha\beta}$	$k^2(2r_3+r_5)-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{i k \not{t}}{\sqrt{2}}$	0	0	0	0
$2^+\,\mathcal{A}^\dagger{}^{\alpha\beta}$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$1^+\,f^\dagger{}^{\alpha\beta}$	$\frac{i k \not{t}}{\sqrt{2}}$	0	0	0	0	0	0
$1^-\,\mathcal{A}^\dagger{}^{\alpha}$	0 0	0		$k^2(2r_3+r_5)+\frac{t_1}{6}$	$\frac{t_1}{3\sqrt{2}}$	0	$\frac{i k \not{t}}{3}$
$2^-\,\mathcal{A}^\dagger{}^{\alpha}$	0	0	0	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	0	$\frac{1}{3} i \sqrt{2}\, k\, \not{t}_1$
$1^-\,f^\dagger{}^{\alpha}$	0 0	0		0	0	0	0
$2^-\,f^\dagger{}^{\alpha}$	0 0	0		$-\frac{1}{3} i k \not{t}$	$-\frac{1}{3} i \sqrt{2}\, k\, \not{t}_1$	0	$\frac{2k^2 t_1}{3}$

	$2^+\,\sigma^\dagger{}^{\alpha\beta}$	$2^+\,\tau^\dagger{}^{\alpha\beta}$	$2^-\,\sigma^\dagger{}^{\alpha\beta\chi}$
$2^+\,\sigma_{\alpha\beta}$	$\frac{2}{(1+2k^2)^2 t_1}$	$-\frac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	0
$2^+\,\tau_{\alpha\beta}$	$\frac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	$\frac{4k^2}{(1+2k^2)^2 t_1}$	0
$2^-\,\sigma_{\alpha\beta\chi}$	0	0	$\frac{2}{t_1}$

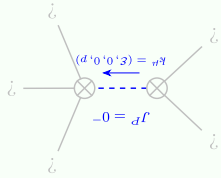
	$2^+\,\mathcal{A}^\dagger{}^{\alpha\beta}$	$2^+\,f^\dagger{}^{\alpha\beta}$	$2^-\,\mathcal{A}^\dagger{}^{\alpha\beta\chi}$
$2^+\,\mathcal{A}_{\alpha\beta}$	$\frac{t_1}{2}$	$\frac{i k \not{t}}{\sqrt{2}}$	0
$2^+\,f_{\alpha\beta}$	$-\frac{i k \not{t}}{\sqrt{2}}$	$k^2 t_1$	0
$2^-\,\mathcal{A}_{\alpha\beta\chi}$	0	0	$\frac{t_1}{2}$

	$0^+\,\mathcal{A}$	$0^+\,f$	$0^+\,f$	$0^-\,\mathcal{A}$
$0^+\,\mathcal{A}^\dagger$	$6k^2 r_3$	0	0	0
$0^+\,f^\dagger$	0	0	0	0
$0^+\,f^\dagger$	0	0	0	0
$0^-\,\mathcal{A}^\dagger$	0	0		$k^2 r_2 - t_1$

	$0^-\,\sigma^\dagger$	$0^+\,\tau^\dagger$	$0^+\,\tau^\dagger$	$0^+\,\sigma^\dagger$
$0^+\,\sigma$	0	0	0	$\frac{1}{6k^2 r_3}$
$0^+\,\tau$	0	0	0	0
$0^+\,\tau$	0	0	0	0
$0^-\,\sigma$	$\frac{1}{k^2 r_2 - t_1}$	0	0	0

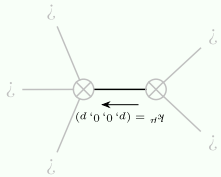
Massive and massless spectra

Massive particle



Pole residue:	$\frac{1}{r_2} > 0$
Squaremass:	$\frac{t_1}{r_2} > 0$
Spin:	0
Parity:	Odd

Massless particle



Pole residue:	$\frac{1}{(2r_3+r_5)t_1{}^2} > 0$
Polarisations:	2

Unitarity conditions