Particle spectrograph

Wave operator and propagator

Spin-parity form	Covariant form	Multiplicities
$^{\#2}0^{+}\tau == 0$	$\partial_{\beta}\partial_{\alpha}\tau^{\alpha\beta} == 0$	1
$^{\#1}0^{+}\tau - 2\,i\,k\,^{\#1}0^{+}\sigma == 0$	$\partial_{\beta}\partial_{\alpha}\tau^{\alpha\beta} == \partial_{\beta}\partial^{\beta}\tau^{\alpha}{}_{\alpha} + 2\,\partial_{\chi}\partial^{\chi}\partial_{\beta}\sigma^{\alpha\beta}{}_{\alpha}$	1
$^{\#2}1^{-}\tau^{\alpha} + 2\,i\,k\,^{\#2}1^{-}\sigma^{\alpha} == 0$	$\partial_{\chi}\partial_{\beta}\partial^{\alpha}\tau^{\beta\chi} == \partial_{\chi}\partial^{\chi}\partial_{\beta}\tau^{\alpha\beta} + 2\,\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial_{\beta}\sigma^{\alpha\beta\chi}$	3
$^{\#1}1^{-}\tau^{\alpha} == 0$	$\partial_{\chi}\partial_{\beta}\partial^{\alpha}\tau^{\beta\chi} == \partial_{\chi}\partial^{\chi}\partial_{\beta}\tau^{\beta\alpha}$	3
$^{\#1}1^{+}\tau^{\alpha\beta} + i\,k\,^{\#2}1^{+}\sigma^{\alpha\beta} == 0$	$\partial_{\chi}\partial^{\alpha}\tau^{\beta\chi} + \partial_{\chi}\partial^{\beta}\tau^{\chi\alpha} + \partial_{\chi}\partial^{\chi}\tau^{\alpha\beta} + 2\,\partial_{\delta}\partial_{\chi}\partial^{\alpha}\sigma^{\beta\chi\delta} + 2\,\partial_{\delta}\partial^{\delta}\partial_{\chi}\sigma^{\alpha\beta\chi} == \partial_{\chi}\partial^{\alpha}\tau^{\chi\beta} + \partial_{\chi}\partial^{\beta}\tau^{\alpha\chi} + \partial_{\chi}\partial^{\chi}\tau^{\beta\alpha} + 2\,\partial_{\delta}\partial_{\chi}\partial^{\beta}\sigma^{\alpha\chi\delta}$	3
$^{\#1}2^{-}\sigma^{\alpha\beta\chi} == 0$	3 $\partial_{\epsilon}\partial_{\delta}\partial^{\chi}\partial^{\alpha}\sigma^{\beta\delta\epsilon} + 3\,\partial_{\epsilon}\partial^{\epsilon}\partial^{\chi}\partial^{\alpha}\sigma^{\beta\delta}{}_{\delta} + 2\,\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\beta}\sigma^{\alpha\chi\delta} + 4\,\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\beta}\sigma^{\alpha\delta\chi} + 2\,\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\beta}\sigma^{\chi\delta\alpha} + 4\,\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\chi}\sigma^{\alpha\beta\delta} + 2\,\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\chi}\sigma^{\alpha\delta\beta} + 2\,\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\delta}\sigma^{\beta\chi\alpha} + 3\,\eta^{\beta\chi}\,\partial_{\phi}\partial^{\phi}\partial_{\epsilon}\partial^{\alpha}\sigma^{\delta\epsilon}{}_{\delta} + 3\,\eta^{\alpha\chi}\,\partial_{\phi}\partial^{\phi}\partial_{\epsilon}\partial_{\delta}\sigma^{\beta\delta\epsilon} + 3\,\eta^{\beta\chi}\,\partial_{\phi}\partial^{\phi}\partial_{\epsilon}\partial^{\epsilon}\sigma^{\alpha\delta}{}_{\delta} == 3\,\partial_{\epsilon}\partial_{\delta}\partial^{\chi}\partial^{\beta}\sigma^{\alpha\delta\epsilon} + 3\,\partial_{\epsilon}\partial^{\epsilon}\partial^{\chi}\partial^{\beta}\sigma^{\alpha\delta}{}_{\delta} + 2\,\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\alpha}\sigma^{\beta\chi\delta} + 4\,\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\alpha}\sigma^{\beta\delta\chi} + 2\,\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\alpha}\sigma^{\chi\delta\beta} + 2\,\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\chi}\sigma^{\beta\delta\alpha} + 4\,\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\delta}\sigma^{\alpha\beta\chi} + 2\,\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\delta}\sigma^{\alpha\chi\beta} + 3\,\eta^{\alpha\chi}\,\partial_{\phi}\partial^{\phi}\partial_{\epsilon}\partial^{\beta}\sigma^{\delta\epsilon}{}_{\delta} + 3\,\eta^{\beta\chi}\,\partial_{\phi}\partial^{\phi}\partial_{\epsilon}\partial_{\delta}\sigma^{\alpha\delta\epsilon} + 3\,\eta^{\alpha\chi}\,\partial_{\phi}\partial^{\phi}\partial_{\epsilon}\partial^{\epsilon}\sigma^{\beta\delta}{}_{\delta}$	5
$^{\#1}2^{+}\tau^{\alpha\beta} == 0$	4 $\partial_{\delta}\partial_{\chi}\partial^{\beta}\partial^{\alpha}\tau^{\chi\delta} + 2\,\partial_{\delta}\partial^{\delta}\partial^{\beta}\partial^{\alpha}\tau^{\chi}{}_{\chi} + 3\,\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\chi}\tau^{\alpha\beta} + 3\,\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\chi}\tau^{\beta\alpha} + 2\,\eta^{\alpha\beta}\,\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial_{\chi}\tau^{\chi\delta} == 3\,\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\alpha}\tau^{\beta\chi} + 3\,\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\alpha}\tau^{\chi\beta} + 3\,\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\beta}\tau^{\alpha\chi} + 3\,\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\beta}\tau^{\chi\alpha} + 2\,\eta^{\alpha\beta}\,\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\delta}\tau^{\chi}{}_{\chi}$	5
Total expected gauge generators:		21

	$^{\#1}1^{+}\sigma_{\alpha\beta}$	$^{\#2}1^{+}\sigma_{\alpha\beta}$	$^{\#1}1^{+}\tau_{\alpha\beta}$	$^{\#1}1^{-}\sigma_{\alpha}$	$^{\#2}1^{-}\sigma_{\alpha}$	$^{\#1}1^{-}\tau_{\alpha}$	$^{\#2}1^{-}\tau_{\alpha}$
$^{\#1}1^{+}\sigma^{\dagger\,\alpha\beta}$	$\frac{1}{k^2(2r_3+r_5)}$	$-\frac{\sqrt{2}}{k^2(1+k^2)(2r_3+r_5)}$	$-\frac{i\sqrt{2}}{k(1+k^2)(2r_3+r_5)}$	0	0	0	0
$^{\#2}1^{+}\sigma^{\dagger\,\alpha\beta}$	$-\frac{\sqrt{2}}{k^2(1+k^2)(2r_3+r_5)}$	$\frac{3k^2(2r_3+r_5)+2t_2}{(k+k^3)^2(2r_3+r_5)t_2}$	$\frac{i(3k^2(2r_3+r_5)+2t_2)}{k(1+k^2)^2(2r_3+r_5)t_2}$	0	0	0	0
$^{\#1}1^{+}\tau^{\dagger\,\alpha\beta}$	$\frac{i\sqrt{2}}{k(1+k^2)(2r_3+r_5)}$	$-\frac{i(3k^2(2r_3+r_5)+2t_2)}{k(1+k^2)^2(2r_3+r_5)t_2}$	$\frac{3k^2(2r_3+r_5)+2t_2}{(1+k^2)^2(2r_3+r_5)t_2}$	0	0	0	0
$^{\#1}1^{-}\sigma^{\dagger\,\alpha}$	0	0	0	$\frac{2}{k^2(r_3+2r_5)}$	$\frac{2\sqrt{2}}{k^2(1+2k^2)(r_3+2r_5)}$	0	$\frac{4i}{k(1+2k^2)(r_3+2r_5)}$
$^{\#2}1^{-}\sigma^{\dagger\,\alpha}$	0	0	0	$\frac{2\sqrt{2}}{k^2(1+2k^2)(r_3+2r_5)}$	$\frac{3k^2(r_3+2r_5)+4t_3}{(k+2k^3)^2(r_3+2r_5)t_3}$	0	$\frac{i\sqrt{2}(3k^2(r_3+2r_5)+4t_3)}{k(1+2k^2)^2(r_3+2r_5)t_3}$
$^{\#1}1^{-}\tau^{\dagger\,\alpha}$	0	0	0	0	0	0	0
$^{\#2}1^{-}\tau^{\dagger\,\alpha}$	0	0	0	$-\frac{4i}{k(1+2k^2)(r_3+2r_5)}$	$-\frac{i\sqrt{2}(3k^2(r_3+2r_5)+4t_3)}{k(1+2k^2)^2(r_3+2r_5)t_3}$	0	$\frac{6k^2(r_3+2r_5)+8t_3}{(1+2k^2)^2(r_3+2r_5)t_3}$

$$
\begin{aligned}
S ==\iiiint\Big(\tfrac{1}{6}\big(&-4t_3\,\mathcal{A}^{\alpha\iota}{}_{\alpha}\,\mathcal{A}_{\iota\theta}{}^{\theta} + 6\,f^{\alpha\beta}\,\tau_{\alpha\beta} + 6\,\mathcal{A}^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} + 8\,t_3\,\mathcal{A}_{\alpha\theta}{}^{\theta}\,\partial_{\iota}f^{\alpha\iota} - 8\,t_3\,\mathcal{A}_{\iota\theta}{}^{\theta}\,\partial^{\iota}f^{\alpha}{}_{\alpha} +\\
&4t_3\,\partial_{\iota}f^{\theta}{}_{\theta}\,\partial^{\iota}f^{\alpha}{}_{\alpha} - 3\,r_3\,\partial_{\beta}\mathcal{A}_{\iota\theta}{}^{\theta}\,\partial^{\iota}\mathcal{A}^{\alpha\beta}{}_{\alpha} - 3\,r_3\,\partial_{\iota}\mathcal{A}_{\beta\theta}{}^{\theta}\,\partial^{\iota}\mathcal{A}^{\alpha\beta}{}_{\alpha} + 4\,t_3\,\partial_{\iota}f^{\alpha\iota}\,\partial_{\theta}f^{\theta}{}_{\alpha} -\\
&8t_3\,\partial^{\iota}f^{\alpha}{}_{\alpha}\,\partial_{\theta}f^{\theta}{}_{\iota} - 3\,r_3\,\partial_{\alpha}\mathcal{A}^{\alpha\beta\iota}\,\partial_{\theta}\mathcal{A}_{\beta\iota}{}^{\theta} + 6\,r_3\,\partial^{\iota}\mathcal{A}^{\alpha\beta}{}_{\alpha}\,\partial_{\theta}\mathcal{A}_{\beta\iota}{}^{\theta} - 3\,r_3\,\partial_{\alpha}\mathcal{A}^{\alpha\beta\iota}\,\partial_{\theta}\mathcal{A}_{\iota\beta}{}^{\theta} +\\
&6r_3\,\partial^{\iota}\mathcal{A}^{\alpha\beta}{}_{\alpha}\,\partial_{\theta}\mathcal{A}_{\iota\beta}{}^{\theta} + 4\,t_2\,\mathcal{A}_{\iota\theta\alpha}\,\partial^{\theta}f^{\alpha\iota} + 2\,t_2\,\partial_{\alpha}f_{\iota\theta}\,\partial^{\theta}f^{\alpha\iota} - t_2\,\partial_{\alpha}f_{\theta\iota}\,\partial^{\theta}f^{\alpha\iota} -\\
&t_2\,\partial_{\iota}f_{\alpha\theta}\,\partial^{\theta}f^{\alpha\iota} + t_2\,\partial_{\theta}f_{\alpha\iota}\,\partial^{\theta}f^{\alpha\iota} - t_2\,\partial_{\theta}f_{\iota\alpha}\,\partial^{\theta}f^{\alpha\iota} - 4\,t_2\,\mathcal{A}_{\alpha\theta\iota}\,(\mathcal{A}^{\alpha\iota\theta} + \partial^{\theta}f^{\alpha\iota}) +\\
&2t_2\,\mathcal{A}_{\alpha\iota\theta}\,(\mathcal{A}^{\alpha\iota\theta} + 2\,\partial^{\theta}f^{\alpha\iota}) - 24\,r_3\,\partial_{\beta}\mathcal{A}_{\iota\theta\alpha}\,\partial^{\theta}\mathcal{A}^{\alpha\beta\iota} + 6\,r_5\,\partial_{\iota}\mathcal{A}_{\theta\kappa}{}^{\kappa}\,\partial^{\theta}\mathcal{A}^{\alpha\iota}{}_{\alpha} -\\
&6r_5\,\partial_{\theta}\mathcal{A}_{\iota\kappa}{}^{\kappa}\,\partial^{\theta}\mathcal{A}^{\alpha\iota}{}_{\alpha} - 6\,r_5\,\partial_{\alpha}\mathcal{A}^{\alpha\iota\theta}\,\partial_{\kappa}\mathcal{A}_{\iota\theta}{}^{\kappa} + 12\,r_5\,\partial^{\theta}\mathcal{A}^{\alpha\iota}{}_{\alpha}\,\partial_{\kappa}\mathcal{A}_{\iota\theta}{}^{\kappa} +\\
&6r_5\,\partial_{\alpha}\mathcal{A}^{\alpha\iota\theta}\,\partial_{\kappa}\mathcal{A}_{\theta\iota}{}^{\kappa} - 12\,r_5\,\partial^{\theta}\mathcal{A}^{\alpha\iota}{}_{\alpha}\,\partial_{\kappa}\mathcal{A}_{\theta\iota}{}^{\kappa}\big)\Big)[t,x,y,z]\,dz\,dy\,dx\,dt
\end{aligned}
$$

	$^{\#1}2^{+}\mathcal{A}_{\alpha\beta}$	$^{\#1}2^{+}f_{\alpha\beta}$	$^{\#1}2^{-}\mathcal{A}_{\alpha\beta\chi}$
$^{\#1}2^{+}\mathcal{A}^{\dagger\,\alpha\beta}$	$-\frac{3k^2r_3}{2}$	0	0
$^{\#1}2^{+}f^{\dagger\,\alpha\beta}$	0	0	0
$^{\#1}2^{-}\mathcal{A}^{\dagger\,\alpha\beta\chi}$	0	0	0

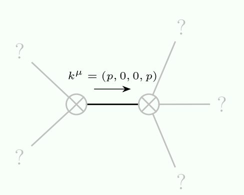
	$^{\#1}2^{+}\sigma_{\alpha\beta}$	$^{\#1}2^{+}\tau_{\alpha\beta}$	$^{\#1}2^{-}\sigma_{\alpha\beta\chi}$
$^{\#1}2^{+}\sigma^{\dagger\,\alpha\beta}$	$-\frac{2}{3k^2r_3}$	0	0
$^{\#1}2^{+}\tau^{\dagger\,\alpha\beta}$	0	0	0
$^{\#1}2^{-}\sigma^{\dagger\,\alpha\beta\chi}$	0	0	0

	$^{\#1}1^{+}\mathcal{A}_{\alpha\beta}$	$^{\#2}1^{+}\mathcal{A}_{\alpha\beta}$	$^{\#1}1^{+}f_{\alpha\beta}$	$^{\#1}1^{-}\mathcal{A}_{\alpha}$	$^{\#2}1^{-}\mathcal{A}_{\alpha}$	$^{\#1}1^{-}f_{\alpha}$	$^{\#2}1^{-}f_{\alpha}$
$^{\#1}1^{+}\mathcal{A}^{\dagger\,\alpha\beta}$	$k^2(2r_3+r_5)+\frac{2t_2}{3}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{1}{3}i\sqrt{2}\,k\,t_2$	0	0	0	0
$^{\#2}1^{+}\mathcal{A}^{\dagger\,\alpha\beta}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{t_2}{3}$	$\frac{i\,k\,t_2}{3}$	0	0	0	0
$^{\#1}1^{+}f^{\dagger\,\alpha\beta}$	$-\frac{1}{3}i\sqrt{2}\,k\,t_2$	$-\frac{1}{3}i\,k\,t_2$	$\frac{k^2t_2}{3}$	0	0	0	0
$^{\#1}1^{-}\mathcal{A}^{\dagger\,\alpha}$	0	0		$k^2(\frac{r_3}{2}+r_5)+\frac{2t_3}{3}$	$-\frac{\sqrt{2}t_3}{3}$	0	$-\frac{2}{3}i\,k\,t_3$
$^{\#2}1^{-}\mathcal{A}^{\dagger\,\alpha}$	0	0		$-\frac{\sqrt{2}t_3}{3}$	$\frac{t_3}{3}$	0	$\frac{1}{3}i\sqrt{2}\,k\,t_3$
$^{\#1}1^{-}f^{\dagger\,\alpha}$	0	0		0	0	0	0
$^{\#2}1^{-}f^{\dagger\,\alpha}$	0	0		$\frac{2i\,k\,t_3}{3}$	$-\frac{1}{3}i\sqrt{2}\,k\,t_3$	0	$\frac{2k^2t_3}{3}$

	$^{\#1}0^{+}\mathcal{A}$	$^{\#1}0^{+}f$	$^{\#2}0^{+}f$	$^{\#1}0^{-}\mathcal{A}$
$^{\#1}0^{+}\mathcal{A}^{\dagger}$	t_3	$-i\sqrt{2}\,k\,t_3$	0	0
$^{\#1}0^{+}f^{\dagger}$	$i\sqrt{2}\,k\,t_3$	$2k^2t_3$	0	0
$^{\#2}0^{+}f^{\dagger}$	0	0	0	0
$^{\#1}0^{-}\mathcal{A}^{\dagger}$	0	0	0	t_2

	$^{\#1}0^{+}\sigma$	$^{\#1}0^{+}\tau$	$^{\#2}0^{+}\tau$	$^{\#1}0^{-}\sigma$
$^{\#1}0^{+}\sigma^{\dagger}$	$\frac{1}{(1+2k^2)^2t_3}$	$-\frac{i\sqrt{2}\,k}{(1+2k^2)^2t_3}$	0	0
$^{\#1}0^{+}\tau^{\dagger}$	$\frac{i\sqrt{2}\,k}{(1+2k^2)^2t_3}$	$\frac{2k^2}{(1+2k^2)^2t_3}$	0	0
$^{\#2}0^{+}\tau^{\dagger}$	0	0	0	0
$^{\#1}0^{-}\sigma^{\dagger}$	0	0	0	$\frac{1}{t_2}$

Massive and massless spectra



Massless particle

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

(No particles)

Unitarity conditions