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
${}^{\#1}2^{+}\tau^{\alpha\beta} - 2\,i\,k\,{}^{\#1}2^{+}\sigma^{\alpha\beta} == 0$	$-i\,(4\,\partial_\delta\partial_\chi\partial^\beta\partial^\alpha\tau^{\chi\delta} + 2\,\partial_\delta\partial^\delta\partial^\beta\partial^\alpha\tau^{\chi}{}_{\chi} - 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\alpha\tau^{\beta\chi} - 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\alpha\tau^{\chi\beta} -$ $3\,\partial_\delta\partial^\delta\partial_\chi\partial^\beta\tau^{\alpha\chi} - 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\beta\tau^{\chi\alpha} + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\chi\tau^{\alpha\beta} +$ $3\,\partial_\delta\partial^\delta\partial_\chi\partial^\beta\partial^\alpha\sigma^{\delta\epsilon}{}_{\delta} - 6\,i\,k^\chi\,\partial_\epsilon\partial_\delta\partial_\chi\partial^\alpha\sigma^{\beta\delta\epsilon} -$ $6\,i\,k^\chi\,\partial_\epsilon\partial_\delta\partial_\chi\partial^\beta\sigma^{\alpha\delta\epsilon} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial_\chi\tau^{\chi\delta} +$ $6\,i\,k^\chi\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial_\chi\sigma^{\alpha\delta\beta} + 6\,i\,k^\chi\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial_\chi\sigma^{\beta\delta\alpha} -$ $2\,\eta^{\alpha\beta}\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\tau^{\chi}{}_{\chi} - 4\,i\,\eta^{\alpha\beta}\,k^\chi\,\partial_\phi\partial^\phi\partial_\epsilon\partial_\chi\sigma^{\delta\epsilon}{}_{\delta}) == 0$	5
Total expected gauge generators:		16

$$S == \iiiint \left(\tfrac{1}{6}\left(2\,t_1\,\mathcal{A}^{\alpha\iota}{}_{\alpha}\,\mathcal{A}_{\iota}{}^{\theta}{}_{\theta} - 4\,t_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} - 4\,t_1\,\mathcal{A}_{\alpha}{}^{\theta}{}_{\theta}\,\partial_\iota f^{\alpha\iota} + 8\,t_3\,\mathcal{A}_{\alpha}{}^{\theta}{}_{\theta}\,\partial_\iota f^{\alpha\iota} + 4\,t_1\,\mathcal{A}_{\iota}{}^{\theta}{}_{\theta}\,\partial^\iota f^{\alpha}{}_{\alpha} - 8\,t_3\,\mathcal{A}_{\iota}{}^{\theta}{}_{\theta}\,\partial^\iota f^{\alpha}{}_{\alpha} - 2\,t_1\,\partial_\iota f^{\theta}{}_{\theta}\,\partial^\iota f^{\alpha}{}_{\alpha} + 4\,t_3\,\partial_\iota f^{\theta}{}_{\theta}\,\partial^\iota f^{\alpha}{}_{\alpha} - 2\,t_1\,\partial_\iota f^{\alpha\iota}\,\partial_\theta f_{\alpha}{}^{\theta} + 4\,t_3\,\partial_\iota f^{\alpha\iota}\,\partial_\theta f_{\alpha}{}^{\theta} + 4\,t_1\,\partial^\iota f^{\alpha}{}_{\alpha}\,\partial_\theta f_{\iota}{}^{\theta} - 8\,t_3\,\partial^\iota f^{\alpha}{}_{\alpha}\,\partial_\theta f_{\iota}{}^{\theta} + 4\,t_1\,\mathcal{A}_{\iota\theta\alpha}\,\partial^\theta f^{\alpha\iota} + 4\,t_2\,\mathcal{A}_{\iota\theta\alpha}\,\partial^\theta f^{\alpha\iota} - 4\,t_1\,\partial_\alpha f_{\iota\theta}\,\partial^\theta f^{\alpha\iota} + 2\,t_2\,\partial_\alpha f_{\iota\theta}\,\partial^\theta f^{\alpha\iota} - 4\,t_1\,\partial_\alpha f_{\theta\iota}\,\partial^\theta f^{\alpha\iota} - t_2\,\partial_\alpha f_{\theta\iota}\,\partial^\theta f^{\alpha\iota} + 2\,t_1\,\partial_\iota f_{\alpha\theta}\,\partial^\theta f^{\alpha\iota} - t_2\,\partial_\iota f_{\alpha\theta}\,\partial^\theta f^{\alpha\iota} + 4\,t_1\,\partial_\theta f_{\alpha\iota}\,\partial^\theta f^{\alpha\iota} + t_2\,\partial_\theta f_{\alpha\iota}\,\partial^\theta f^{\alpha\iota} + 2\,t_1\,\partial_\theta f_{\iota\alpha}\,\partial^\theta f^{\alpha\iota} - t_2\,\partial_\theta f_{\iota\alpha}\,\partial^\theta f^{\alpha\iota} + 2\,(t_1+t_2)\,\mathcal{A}_{\alpha\iota\theta}\,(\mathcal{A}^{\alpha\iota\theta} + 2\,\partial^\theta f^{\alpha\iota}) + 2\,\mathcal{A}_{\alpha\theta\iota}\,((t_1-2\,t_2)\,\mathcal{A}^{\alpha\iota\theta} + 2\,(2\,t_1-t_2)\,\partial^\theta f^{\alpha\iota}) + 8\,r_2\,\partial_\beta\mathcal{A}_{\alpha\iota\theta}\,\partial^\theta\mathcal{A}^{\alpha\beta\iota} - 4\,r_2\,\partial_\beta\mathcal{A}_{\alpha\theta\iota}\,\partial^\theta\mathcal{A}^{\alpha\beta\iota} + 4\,r_2\,\partial_\beta\mathcal{A}_{\iota\theta\alpha}\,\partial^\theta\mathcal{A}^{\alpha\beta\iota} - 2\,r_2\,\partial_\iota\mathcal{A}_{\alpha\beta\theta}\,\partial^\theta\mathcal{A}^{\alpha\beta\iota} + 2\,r_2\,\partial_\theta\mathcal{A}_{\alpha\beta\iota}\,\partial^\theta\mathcal{A}^{\alpha\beta\iota} - 4\,r_2\,\partial_\theta\mathcal{A}_{\alpha\iota\beta}\,\partial^\theta\mathcal{A}^{\alpha\beta\iota}\right)\right)[t,x,y,z]\,dz\,dy\,dx\,dt$$

	${}^{\#1}1^{+}\mathcal{A}_{\alpha\beta}$	${}^{\#2}1^{+}\mathcal{A}_{\alpha\beta}$	${}^{\#1}1^{+}f_{\alpha\beta}$	${}^{\#1}1^{-}\mathcal{A}_{\alpha}$	${}^{\#2}1^{-}\mathcal{A}_{\alpha}$	${}^{\#1}1^{-}f_{\alpha}$	${}^{\#2}1^{-}f_{\alpha}$
${}^{\#1}1^{+}\mathcal{A}\dagger^{\alpha\beta}$	$\frac{1}{6}(t_1+4\,t_2)$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$-\frac{i\,k(t_1-2t_2)}{3\sqrt{2}}$	0	0		0
${}^{\#2}1^{+}\mathcal{A}\dagger^{\alpha\beta}$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$\frac{t_1+t_2}{3}$	$\frac{1}{3}\,i\,k(t_1+t_2)$	0	0		0
${}^{\#1}1^{+}f\dagger^{\alpha\beta}$	$\frac{i\,k(t_1-2t_2)}{3\sqrt{2}}$	$-\frac{1}{3}\,i\,k(t_1+t_2)$	$\frac{1}{3}k^2(t_1+t_2)$	0	0		0
${}^{\#1}1^{-}\mathcal{A}\dagger^{\alpha}$	0	0	0	$\frac{1}{6}(t_1+4\,t_3)$	$\frac{t_1-2t_3}{3\sqrt{2}}$	0	$\frac{1}{3}\,i\,k(t_1-2\,t_3)$
${}^{\#2}1^{-}\mathcal{A}\dagger^{\alpha}$	0	0	0	$\frac{t_1-2t_3}{3\sqrt{2}}$	$\frac{t_1+t_3}{3}$	0	$\frac{1}{3}\,i\,\sqrt{2}\,k\,(t_1+t_3)$
${}^{\#1}1^{-}f\dagger^{\alpha}$	0	0	0	0	0	0	0
${}^{\#2}1^{-}f\dagger^{\alpha}$	0	0	0	$-\frac{1}{3}\,i\,k(t_1-2\,t_3)$	$-\frac{1}{3}\,i\,\sqrt{2}\,k\,(t_1+t_3)$	0	$\frac{2}{3}k^2(t_1+t_3)$

	${}^{\#1}0^{+}\mathcal{A}$	${}^{\#1}0^{+}f$	${}^{\#2}0^{+}f$	${}^{\#1}0^{-}\mathcal{A}$
${}^{\#1}0^{+}\mathcal{A}\dagger$	t_3	$-i\,\sqrt{2}\,k\,t_3$	0	0
${}^{\#1}0^{+}f\dagger$	$i\,\sqrt{2}\,k\,t_3$	$2k^2\,t_3$	0	0
${}^{\#2}0^{+}f\dagger$	0	0	0	0
${}^{\#1}0^{-}\mathcal{A}\dagger$	0	0	0	$k^2\,r_2+t_2$

	${}^{\#1}0^{+}\sigma$	${}^{\#1}0^{+}\tau$	${}^{\#2}0^{+}\tau$	${}^{\#1}0^{-}\sigma$
${}^{\#1}0^{+}\sigma\dagger$	$\frac{1}{(1+2k^2)^2\,t_3}$	$-\frac{i\,\sqrt{2}\,k}{(1+2k^2)^2\,t_3}$	0	0
${}^{\#1}0^{+}\tau\dagger$	$\frac{i\,\sqrt{2}\,k}{(1+2k^2)^2\,t_3}$	$\frac{2k^2}{(1+2k^2)^2\,t_3}$	0	0
${}^{\#2}0^{+}\tau\dagger$	0	0	0	0
${}^{\#1}0^{-}\sigma\dagger$	0	0	0	$\frac{1}{k^2\,r_2+t_2}$

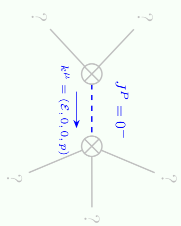
	${}^{\#1}2^{+}\sigma_{\alpha\beta}$	${}^{\#1}2^{+}\tau_{\alpha\beta}$	${}^{\#1}2^{-}\sigma_{\alpha\beta\chi}$
${}^{\#1}2^{+}\sigma\dagger^{\alpha\beta}$	$\frac{2}{(1+2k^2)^2\,t_1}$	$-\frac{2\,i\,\sqrt{2}\,k}{(1+2k^2)^2\,t_1}$	0
${}^{\#1}2^{+}\tau\dagger^{\alpha\beta}$	$\frac{2\,i\,\sqrt{2}\,k}{(1+2k^2)^2\,t_1}$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

	${}^{\#1}2^{+}\mathcal{A}_{\alpha\beta}$	${}^{\#1}2^{+}f_{\alpha\beta}$	${}^{\#1}2^{-}\mathcal{A}_{\alpha\beta\chi}$
${}^{\#1}2^{+}\mathcal{A}\dagger^{\alpha\beta}$	$\frac{t_1}{2}$	$-\frac{i\,k\,t_1}{\sqrt{2}}$	0
${}^{\#1}2^{+}f\dagger^{\alpha\beta}$	$\frac{i\,k\,t_1}{\sqrt{2}}$	$k^2\,t_1$	0
${}^{\#1}2^{-}\mathcal{A}\dagger^{\alpha\beta\chi}$	0	0	$\frac{t_1}{2}$

	${}^{\#1}1^{+}\sigma_{\alpha\beta}$	${}^{\#2}1^{+}\sigma_{\alpha\beta}$	${}^{\#1}1^{+}\tau_{\alpha\beta}$	${}^{\#1}1^{-}\sigma_{\alpha}$	${}^{\#2}1^{-}\sigma_{\alpha}$	${}^{\#1}1^{-}\tau_{\alpha}$	${}^{\#2}1^{-}\tau_{\alpha}$
${}^{\#1}1^{+}\sigma\dagger^{\alpha\beta}$	$\frac{2(t_1+t_2)}{3\,t_1\,t_2}$	$\frac{\sqrt{2}\,(t_1-2t_2)}{3(1+k^2)\,t_1\,t_2}$	$\frac{i\,\sqrt{2}\,k\,(t_1-2t_2)}{3(1+k^2)\,t_1\,t_2}$	0	0 0		0
${}^{\#2}1^{+}\sigma\dagger^{\alpha\beta}$	$\frac{\sqrt{2}\,(t_1-2t_2)}{3(1+k^2)\,t_1\,t_2}$	$\frac{t_1+4t_2}{3(1+k^2)^2\,t_1\,t_2}$	$\frac{i\,k(t_1+4t_2)}{3(1+k^2)^2\,t_1\,t_2}$	0	0 0		0
${}^{\#1}1^{+}\tau\dagger^{\alpha\beta}$	$-\frac{i\,\sqrt{2}\,k\,(t_1-2t_2)}{3(1+k^2)\,t_1\,t_2}$	$-\frac{i\,k(t_1+4t_2)}{3(1+k^2)^2\,t_1\,t_2}$	$\frac{k^2\,(t_1+4t_2)}{3(1+k^2)^2\,t_1\,t_2}$	0	0 0		0
${}^{\#1}1^{-}\sigma\dagger^{\alpha}$	0	0	0	$\frac{2(t_1+t_3)}{3\,t_1\,t_3}$	$-\frac{\sqrt{2}\,(t_1-2t_3)}{3(1+2\,k^2)\,t_1\,t_3}$	0	$-\frac{2\,i\,k\,t_1-4\,i\,k\,t_3}{3\,t_1\,t_3+6\,k^2\,t_1\,t_3}$
${}^{\#2}1^{-}\sigma\dagger^{\alpha}$	0	0	0	$-\frac{\sqrt{2}\,(t_1-2t_3)}{3(1+2\,k^2)\,t_1\,t_3}$	$\frac{t_1+4t_3}{3(1+2\,k^2)^2\,t_1\,t_3}$	0	$\frac{i\,\sqrt{2}\,k\,(t_1+4t_3)}{3(1+2\,k^2)^2\,t_1\,t_3}$
${}^{\#1}1^{-}\tau\dagger^{\alpha}$	0	0	0	0	0 0		0
${}^{\#2}1^{-}\tau\dagger^{\alpha}$	0	0	0	$\frac{2\,i\,k(t_1-2t_3)}{3\,t_1\,t_3+6\,k^2\,t_1\,t_3}$	$-\frac{i\,\sqrt{2}\,k\,(t_1+4t_3)}{3(1+2\,k^2)^2\,t_1\,t_3}$	0	$\frac{2\,k^2\,(t_1+4t_3)}{3(1+2\,k^2)^2\,t_1\,t_3}$

Massive and massless spectra

	Massive particle
Pole residue:	$-\frac{1}{r_2} > 0$
Square mass:	$-\frac{t_2}{r_2} > 0$
Spin:	0
Parity:	Odd



(No particles)

Unitarity conditions