Particle spectrograph

Wave operator and propagator

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

$$\mathcal{S} == \iiiint \Big(\frac{1}{6}\,(6\,t_1\,\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} - 12\ t_1\ \mathcal{A}_\alpha{}^\theta{}_\theta\ \partial_\iota f^{\alpha\iota} + 12\ t_1\ \mathcal{A}_\iota{}^\theta{}_\theta\ \partial^\iota f^\alpha{}_\alpha - 6\ t_1\,\partial_\iota f^{\theta}{}_{\theta}\ \partial^\iota f^\alpha{}_\alpha - 6\ t_1\,\partial_\iota f^{\alpha\iota}\ \partial_\theta f_\alpha{}^\theta + 12\ t_1\,\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}\Big)\Big)[t, x, y, z]\,dt\ dz\ dt\ dy\ dt\ dx\ dt\ dt$$

	$1^+\,\sigma_{\alpha\beta}$	$2^+\,\sigma_{\alpha\beta}$	$1^+\,\tau_{\alpha\beta}$	$1^-\,\sigma_\alpha$	$2^-\,\sigma_\alpha$	$1^-\,\tau_\alpha$	$2^-\,\tau_\alpha$
$1^+\,\sigma\dagger^{\alpha\beta}$	$\frac{2(t_1+t_2)}{3t_1t_2}$	$\frac{\sqrt{2}\,(t_1-2t_2)}{3(1+k^2)t_1t_2}$	$\frac{i\sqrt{2}\,k\,(t_1-2t_2)}{3(1+k^2)t_1t_2}$	0	0 0		0
$2^+\,\sigma\dagger^{\alpha\beta}$	$\frac{\sqrt{2}\,(t_1-2t_2)}{3(1+k^2)t_1t_2}$	$\frac{t_1+4t_2}{3(1+k^2)^2t_1t_2}$	$\frac{i\,k(t_1+4t_2)}{3(1+k^2)^2t_1t_2}$	0	0 0		0
$1^+\,\tau\dagger^{\alpha\beta}$	$-\frac{i\sqrt{2}\,k\,(t_1-2t_2)}{3(1+k^2)t_1t_2}$	$-\frac{i\,k(t_1+4t_2)}{3(1+k^2)^2t_1t_2}$	$\frac{k^2(t_1+4t_2)}{3(1+k^2)^2t_1t_2}$	0	0 0		0
$1^-\,\sigma\dagger^\alpha$	0	0	0 0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	$\frac{1}{(1+2k^2)^2t_1}$	0	$\frac{i\sqrt{2}\,k}{(1+2k^2)^2t_1}$
$2^-\,\sigma\dagger^\alpha$	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	$\frac{1}{(1+2k^2)^2t_1}$	0	$\frac{i\sqrt{2}\,k}{(1+2k^2)^2t_1}$
$1^-\,\tau\dagger^\alpha$	0	0	0	0 0		0	0
$2^-\,\tau\dagger^\alpha$	0	0	0	$-\frac{2\,i\,k}{t_1+2k^2t_1}$	$-\frac{i\sqrt{2}\,k}{(1+2k^2)^2t_1}$	0	$\frac{2k^2}{(1+2k^2)^2t_1}$

	$0^+\,\sigma$	$0^+\,\tau$	$0^-\,\tau$	$0^-\,\sigma$
$0^+\,\sigma\dagger$	0	0	$-\frac{1}{(1+2k^2)^2t_1}$	$-\frac{1}{(1+2k^2)^2t_1}$
$0^+\,\tau\dagger$	0	0	$-\frac{i\sqrt{2}\,k}{(1+2k^2)^2t_1}$	$-\frac{i\sqrt{2}\,k}{(1+2k^2)^2t_1}$
$0^-\,\tau\dagger$	0	0	0	0
$0^-\,\sigma\dagger$	0	0	0	$\frac{1}{k^2r_2+t_2}$

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

	$0^+\,\mathcal{A}$	$0^+\,f$	$0^-\,f$	$0^-\,\mathcal{A}$
$0^+\,\mathcal{A}\dagger$	0	0	$-i\sqrt{2}\,k\,t_1$	$-t_1$
$0^+\,f\dagger$	0	0	$-2k^2t_1$	$i\sqrt{2}\,k\,t_1$
$0^-\,f\dagger$	0	0	0	0
$0^-\,\mathcal{A}\dagger$	0	0	0	$k^2r_2+t_2$

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

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

	$0^+\,\sigma$	$0^+\,\tau$	$0^-\,\sigma$
$0^+\,\mathcal{A}\dagger$	0	0	0
$0^+\,f\dagger$	0	0	0
$0^-\,f\dagger$	0	0	0
$0^-\,\mathcal{A}\dagger$	0	0	$k^2r_2+t_2$

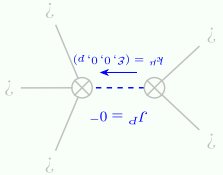
Massive and massless spectra

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

Unitarity conditions

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

Massive particle



(No particles)