Particle spectrograph

Wave operator and propagator

Source constraints		Multiplicities
SO(3) irreps	Fundamental fields	
$\tau_{0^+}^{\#2} == 0$	$\partial_\beta \sigma_\alpha{}^{\alpha\beta} == 0$	1
$\tau_{0^+}^{\#1} == 0$	$\partial_\beta \sigma_\alpha{}^{\alpha\beta} == \partial_\beta \sigma^\beta{}_\alpha{}^\alpha$	1
$\sigma_{0^+}^{\#1} == 0$	$\partial_\beta \sigma^{\alpha\beta}{}_\alpha == 0$	1
$\tau_1^{\#2\,\alpha} == 0$	$\partial_\beta \sigma^{\beta\gamma}{}_\gamma{}^\alpha == \partial_\chi \sigma^{\chi\beta}{}_\beta{}^\alpha$	3
$\tau_1^{\#1\,\alpha} == 0$	$\partial_\chi \sigma^{\alpha\beta}{}_\gamma{}^\gamma == \partial_\chi \sigma^{\chi\beta}{}_\beta{}^\alpha$	3
$\sigma_1^{\#2\,\alpha} == 0$	$\partial_\chi \sigma^{\alpha\beta}{}_\beta{}^\chi == 0$	3
$\sigma_1^{\#1\,\alpha} == 0$	$\partial_\chi \sigma^\alpha{}_\beta{}^{\beta\chi} == \partial_\chi \sigma^{\alpha\beta}{}_\beta{}^\chi$	3
$\tau_1^{\#1\,\alpha\beta} + i\,k\,\sigma_1^{\#1\,\alpha\beta} == 0$	$\partial_\chi \sigma^{\alpha\beta}{}_\gamma{}^{\gamma\chi} + \partial_\chi \sigma^{\beta\gamma}{}_\gamma{}^{\alpha\chi} + \partial_\chi \sigma^{\alpha\gamma}{}_\gamma{}^{\beta\chi} == \partial_\delta \sigma^{\beta\gamma}{}_\gamma{}^{\alpha\delta} + \partial_\delta \sigma^{\alpha\gamma}{}_\gamma{}^{\beta\delta} + \partial_\delta \sigma^{\beta\delta}{}_\gamma{}^{\alpha\gamma}$	3
$\sigma_1^{\#1\,\alpha\beta} == \sigma_{1^+}^{\#2\,\alpha\beta}$	$3\,\partial_\delta \partial_\chi \sigma^{\alpha\beta}{}_\gamma{}^{\gamma\chi\delta} + 2\,\partial_\delta \partial_\chi \sigma^{\alpha\chi}{}_\gamma{}^{\beta\delta} + 2\,\partial_\delta \partial_\chi \sigma^{\beta\chi}{}_\gamma{}^{\alpha\delta} == 3\,\partial_\delta \partial_\chi \sigma^{\alpha\chi}{}_\gamma{}^{\beta\delta}$	3
$\sigma_2^{\#1\,\alpha\beta\chi} == 0$	$3\,\partial_\epsilon \partial_\delta \partial_\gamma \sigma^{\beta\delta\epsilon} + 3\,\partial_\epsilon \partial_\delta \partial_\gamma \sigma^{\alpha\delta\epsilon} + 2\,\partial_\epsilon \partial_\delta \partial_\gamma \sigma^{\alpha\chi\delta} + 4\,\partial_\epsilon \partial_\delta \partial_\gamma \sigma^{\alpha\delta\chi} + 2\,\partial_\epsilon \partial_\delta \partial_\gamma \sigma^{\alpha\chi\delta} + 4\,\partial_\epsilon \partial_\delta \partial_\gamma \sigma^{\alpha\delta\beta} + 2\,\partial_\epsilon \partial_\delta \partial_\gamma \sigma^{\beta\chi\delta} + 3\,\eta^{\alpha\chi}\,\partial_\phi \partial_\epsilon \partial_\delta \sigma^{\beta\epsilon}{}_\gamma{}^\phi + 3\,\eta^{\alpha\chi}\,\partial_\phi \partial_\epsilon \partial_\delta \sigma^{\beta\delta\epsilon}{}^\phi + 3\,\eta^{\beta\chi}\,\partial_\phi \partial_\epsilon \partial_\delta \sigma^{\alpha\delta\epsilon}{}^\phi == 3\,\partial_\epsilon \partial_\delta \partial_\gamma \sigma^{\beta\chi\delta} \sigma^{\alpha\delta\epsilon}{}_\gamma{}^\phi + 2\,\partial_\epsilon \partial_\delta \partial_\gamma \sigma^{\alpha\chi\delta} \sigma^{\beta\delta\epsilon}{}_\gamma{}^\phi + 2\,\partial_\epsilon \partial_\delta \partial_\gamma \sigma^{\alpha\beta\chi} \sigma^{\delta\epsilon}{}_\gamma{}^\phi + 4\,\partial_\epsilon \partial_\delta \partial_\gamma \sigma^{\alpha\beta\chi} \sigma^{\delta\epsilon}{}_\gamma{}^\phi + 3\,\eta^{\alpha\chi}\,\partial_\phi \partial_\epsilon \partial_\delta \sigma^{\beta\delta\epsilon} + 3\,\eta^{\beta\chi}\,\partial_\phi \partial_\epsilon \partial_\delta \sigma^{\alpha\delta\epsilon} + 3\,\eta^{\alpha\chi}\,\partial_\phi \partial_\epsilon \partial_\delta \sigma^{\beta\delta\epsilon}$	5
$\tau_{2^+}^{\#1\,\alpha\beta} == 0$	$4\,\partial_\delta \partial_\chi \partial_\beta \sigma^\alpha{}_\gamma{}^{\gamma\chi\delta} + 2\,\partial_\delta \partial_\beta \partial^\alpha \tau^\chi{}_\chi + 3\,\partial_\delta \partial^\beta \partial_\chi \tau^{\alpha\chi} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \tau^\chi{}_\chi + 3\,\partial_\delta \partial^\beta \partial_\chi \tau^{\alpha\delta} == 3\,\partial_\delta \partial^\beta \partial_\chi \tau^{\alpha\chi} + 3\,\partial_\delta \partial^\alpha \partial_\chi \tau^{\beta\chi} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \tau^{\delta\chi}$	5
$\sigma_{2^+}^{\#1\,\alpha\beta} == 0$	$3\,\partial_\delta \partial_\chi \sigma^{\alpha\beta}{}_\gamma{}^{\gamma\chi\delta} + 3\,\partial_\delta \partial_\chi \sigma^{\alpha\chi}{}_\gamma{}^{\beta\delta} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\delta\chi}{}_\chi$	5
Total constraints/gauge generators:		36

Quadratic (free) action

$$S == \int\int\int\int \frac{1}{6} (6\, f^{\alpha\beta}{}_{\tau_{\alpha\beta}} + 6\, \mathcal{A}^{\alpha\beta\chi}{}_{\sigma_{\alpha\beta\chi}} + 4\, t_2\, \mathcal{A}_{\iota\theta\alpha}{}^{\theta} f^{\alpha\iota} + 2\, t_2\, \partial_\alpha f_{\iota\theta}{}^{\theta} f^{\alpha\iota} - t_2\, \partial_\iota f_{\alpha\theta}{}^{\theta} f^{\alpha\iota} + t_2\, \partial_\theta f_{\alpha\iota}{}^{\theta} f^{\alpha\iota} - 4\, t_2\, \mathcal{A}_{\alpha\theta\iota}{}^{\theta} f^{\alpha\iota} + 2\, t_2\, \mathcal{A}_{\alpha\iota\theta} (\mathcal{A}^{\alpha\iota\theta} + \partial^\theta f^{\alpha\iota}) + 8\, r_2\, \partial_\theta \mathcal{A}_{\alpha\iota\theta} \partial^\theta \mathcal{A}^{\alpha\theta\iota} - 4\, r_2\, \partial_\theta \mathcal{A}_{\alpha\theta\iota} \partial^\theta \mathcal{A}^{\alpha\iota\theta} + 4\, r_2\, \partial_\iota \mathcal{A}_{\iota\theta\alpha} \partial^\theta \mathcal{A}^{\alpha\theta\iota} - 2\, r_2\, \partial_\iota \mathcal{A}_{\alpha\theta\beta} \partial^\theta \mathcal{A}^{\alpha\theta\iota} + 2\, r_2\, \partial_\alpha \mathcal{A}_{\alpha\iota\theta} \partial^\theta \mathcal{A}^{\alpha\theta\iota}) [t, x, y, z] dz\, dy\, dx\, dt$$

$\mathcal{A}_{1^+}^{\#1\,\alpha\beta}$ †

	$\mathcal{A}_{1^+}^{\#1\,\alpha\beta}$	$\mathcal{A}_{1^+}^{\#2\,\alpha\beta}$	$f_{1^+}^{\#1\,\alpha\beta}$	$\mathcal{A}_{1^-}^{\#1\,\alpha}$	$\mathcal{A}_{1^-}^{\#2\,\alpha}$	$f_{1^-}^{\#1\,\alpha}$	$f_{1^-}^{\#2\,\alpha}$
$\mathcal{A}_{1^+}^{\#1\,\alpha\beta}$	$\frac{2\,t_2}{3}$	$\frac{\sqrt{2}\,t_2}{3}$	$\frac{1}{3}\,i\,\sqrt{2}\,k\,t_2$	0	0	0	0
$\mathcal{A}_{1^+}^{\#2\,\alpha\beta}$	$\frac{\sqrt{2}\,t_2}{3}$	$\frac{t_2}{3}$	$\frac{i\,k\,t_2}{3}$	0	0	0	0
$f_{1^+}^{\#1\,\alpha\beta}$	$-\frac{1}{3}\,i\,\sqrt{2}\,k\,t_2$	$-\frac{1}{3}\,i\,k\,t_2$	$\frac{k^2\,t_2}{3}$	0	0	0	0
$\mathcal{A}_{1^-}^{\#1\,\alpha}$	0	0	0	0	0	0	0
$\mathcal{A}_{1^-}^{\#2\,\alpha}$	0	0	0	0	0	0	0
$f_{1^-}^{\#1\,\alpha}$	0	0	0	0	0	0	0
$f_{1^-}^{\#2\,\alpha}$	0	0	0	0	0	0	0

$\mathcal{A}_{0^+}^{\#1}$ †

	$\mathcal{A}_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\mathcal{A}_{0^-}^{\#1}$
$\mathcal{A}_{0^+}^{\#1}$ †	0	0	0	0
$f_{0^+}^{\#1}$ †	0	0	0	0
$f_{0^+}^{\#2}$ †	0	0	0	0
$\mathcal{A}_{0^-}^{\#1}$ †	0	0	0	$k^2\,r_2 + t_2$

$\mathcal{A}_{2^+}^{\#1\,\alpha\beta}$ †

	$\mathcal{A}_{2^+}^{\#1\,\alpha\beta}$	$f_{2^+}^{\#1\,\alpha\beta}$	$\mathcal{A}_{2^-}^{\#1\,\alpha\beta\chi}$
$\mathcal{A}_{2^+}^{\#1\,\alpha\beta}$ †	0	0	0
$f_{2^+}^{\#1\,\alpha\beta}$ †	0	0	0
$\mathcal{A}_{2^-}^{\#1\,\alpha\beta\chi}$ †	0	0	0

$\sigma_1^{\#1\,\alpha\beta}$ †

	$\sigma_1^{\#1\,\alpha\beta}$	$\tau_1^{\#1\,\alpha\beta}$	$\sigma_1^{\#2\,\alpha\beta}$	$\tau_1^{\#1\,\alpha}$	$\tau_1^{\#2\,\alpha}$
$\sigma_1^{\#1\,\alpha\beta}$ †	$\frac{6}{(3+k^2)\,r_2 + t_2}$	$\frac{3\,\sqrt{2}\,(1+k^2)\,r_2 + 3\,t_2}{(3+k^2)\,r_2 + t_2}$	$\frac{3\,\sqrt{2}}{(3+k^2)\,r_2 + t_2}$	$-\frac{3\,i\,\sqrt{2}\,k}{(3+k^2)\,r_2 + t_2}$	0
$\tau_1^{\#1\,\alpha\beta}$ †	$\frac{3\,\sqrt{2}\,(1+k^2)\,r_2 + 3\,t_2}{(3+k^2)\,r_2 + t_2}$	$\frac{3\,(1+k^2)\,r_2 + 3\,t_2}{(3+k^2)\,r_2 + t_2}$	$\frac{3\,i\,k}{(3+k^2)\,r_2 + t_2}$	$-\frac{3\,i\,k}{(3+k^2)\,r_2 + t_2}$	0
$\sigma_1^{\#2\,\alpha\beta}$ †	$\frac{3\,\sqrt{2}}{(3+k^2)\,r_2 + t_2}$	$\frac{3\,i\,k}{(3+k^2)\,r_2 + t_2}$	$\frac{3\,k^2}{(3+k^2)\,r_2 + t_2}$	0	0
$\tau_1^{\#1\,\alpha}$ †	$-\frac{3\,i\,\sqrt{2}\,k}{(3+k^2)\,r_2 + t_2}$	$-\frac{3\,i\,k}{(3+k^2)\,r_2 + t_2}$	0	$\frac{3\,k^2}{(3+k^2)\,r_2 + t_2}$	0
$\sigma_1^{\#2\,\alpha}$ †	0	0	0	0	0
$\tau_1^{\#1\,\alpha}$ †	0	0	0	0	0

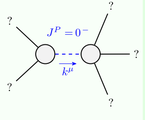
$\sigma_{2^+}^{\#1\,\alpha\beta\chi}$ †

	$\sigma_{2^+}^{\#1\,\alpha\beta\chi}$
$\sigma_{2^+}^{\#1\,\alpha\beta\chi}$ †	0
$\tau_{2^+}^{\#1\,\alpha\beta}$ †	0
$\sigma_2^{\#1\,\alpha\beta\chi}$ †	0

$\sigma_{0^+}^{\#1}$ †

	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\sigma_{0^+}^{\#1}$ †	0	0	0	0
$\tau_{0^+}^{\#1}$ †	0	0	0	0
$\tau_{0^+}^{\#2}$ †	0	0	0	0
$\sigma_{0^-}^{\#1}$ †	0	0	0	$\frac{1}{k^2\,r_2 + t_2}$

Massive and massless spectra



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

(No massless particles)

Unitarity conditions

$r_2 < 0 \;\&\&\; t_2 > 0$