

Particle spectrograph

Wave operator and propagator

Source constraints		
SO(3) irreps	Fundamental fields	Multiplicities
$\tau_{0+}^{\#2} == 0$	$\partial_{\beta}\partial_{\alpha}\tau^{a\beta} == 0$	1
$\tau_{0+}^{\#1} == 0$	$\partial_{\beta}\partial_{\alpha}\tau^{a\beta} == \partial_{\beta}\partial_{\beta}\tau^{\alpha}_{\alpha}$	1
$\sigma_{0+}^{\#1} == 0$	$\partial_{\beta}\sigma^{a\beta}_{\alpha} == 0$	1
$\tau_{1-}^{\#2\alpha} == 0$	$\partial_{\chi}\partial_{\beta}\partial^{\alpha}\tau^{\beta\chi} == \partial_{\chi}\partial^{\chi}\partial_{\beta}\tau^{a\beta}$	3
$\tau_{1-}^{\#1\alpha} == 0$	$\partial_{\chi}\partial_{\beta}\partial^{\alpha}\tau^{\beta\chi} == \partial_{\chi}\partial^{\chi}\partial_{\beta}\tau^{t\alpha}$	3
$\sigma_{1-}^{\#2\alpha} == 0$	$\partial_{\chi}\partial_{\beta}\sigma^{a\beta\chi} == 0$	3
$\tau_{1+}^{\#1\alpha\beta} + i\hbar k\sigma_{1+}^{\#2\alpha\beta} == 0$	$\partial_{\chi}\partial^{\alpha}\tau^{\beta\chi} + \partial_{\chi}\partial^{\beta}\tau^{\alpha\chi} + \partial_{\chi}\partial^{\chi}\tau^{a\beta} +$ $\partial_{\chi}\partial^{\alpha}\tau^{\chi\beta} + \partial_{\chi}\partial^{\beta}\tau^{\alpha\chi} +$ $\partial_{\chi}\partial^{\chi}\tau^{\beta\alpha} + 2\partial_{\beta}\partial_{\chi}\partial^{\beta}\sigma^{\alpha\chi\delta}$	3
$\sigma_{2-}^{\#1\alpha\beta\chi} == 0$	$3\partial_{\epsilon}\partial_{\delta}\partial^{\chi}\partial^{\beta}\sigma^{\alpha\delta\epsilon} + 3\partial_{\epsilon}\partial^{\epsilon}\partial^{\chi}\partial^{\alpha}\sigma^{\beta\delta}_{\delta} +$ $2\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\beta}\sigma^{\alpha\chi\delta} + 4\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\beta}\sigma^{\alpha\delta\chi} +$ $2\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\beta}\sigma^{\chi\delta\alpha} + 4\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\chi}\sigma^{\alpha\beta\delta} +$ $2\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\chi}\sigma^{\alpha\delta\beta} + 2\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\beta}\sigma^{\beta\chi\alpha} +$ $3\eta^{\beta\chi}\partial_{\theta}\partial^{\theta}\partial_{\epsilon}\partial^{\alpha}\sigma^{\delta\epsilon}_{\delta} +$ $3\eta^{\alpha\chi}\partial_{\theta}\partial^{\theta}\partial_{\epsilon}\partial_{\delta}\sigma^{\beta\delta\epsilon} +$ $3\eta^{\beta\chi}\partial_{\theta}\partial^{\theta}\partial_{\epsilon}\partial^{\alpha}\sigma^{\delta\epsilon}_{\delta} ==$ $3\partial_{\epsilon}\partial_{\delta}\partial^{\chi}\partial^{\beta}\sigma^{\alpha\delta\epsilon} + 3\partial_{\epsilon}\partial^{\epsilon}\partial^{\chi}\partial^{\beta}\sigma^{\alpha\delta}_{\delta} +$ $2\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\beta}\sigma^{\beta\chi\delta} + 4\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\beta}\sigma^{\delta\chi\chi} +$ $2\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\beta}\sigma^{\chi\delta\alpha} + 2\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\chi}\sigma^{\beta\delta\alpha} +$ $4\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\beta}\sigma^{\alpha\beta\chi} + 2\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\beta}\sigma^{\alpha\chi\beta} +$ $3\eta^{\alpha\chi}\partial_{\theta}\partial^{\theta}\partial_{\epsilon}\partial^{\beta}\sigma^{\delta\epsilon}_{\delta} +$ $3\eta^{\beta\chi}\partial_{\theta}\partial^{\theta}\partial_{\delta}\partial_{\delta}\sigma^{\alpha\delta\epsilon} +$ $3\eta^{\alpha\chi}\partial_{\theta}\partial^{\theta}\partial_{\epsilon}\partial^{\delta}\sigma^{\beta\delta\delta}_{\delta}$	5
$\tau_{2+}^{\#1\alpha\beta} == 0$	$4\partial_{\delta}\partial_{\chi}\partial^{\beta}\partial^{\alpha}\tau^{\chi\delta} + 2\partial_{\delta}\partial^{\delta}\partial^{\beta}\partial^{\alpha}\tau^{\chi}_{\chi} +$ $3\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\alpha}\tau^{\chi\beta} + 3\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\alpha}\tau^{\beta\alpha} +$ $2\eta^{\alpha\beta}\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial_{\chi}\tau^{\chi\delta} ==$ $3\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\alpha}\tau^{\beta\chi} + 3\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\alpha}\tau^{\chi\beta} +$ $3\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\beta}\tau^{\alpha\chi} + 3\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\beta}\tau^{\chi\alpha} +$ $2\eta^{\alpha\beta}\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial^{\alpha}\tau^{\chi}_{\chi}$	5
Total constraints/gauge generators:		25

Quadratic (free) action	
S== $\iiint\iiint\big(\frac{1}{6}f^{\alpha\beta}\tau_{\alpha\beta}+6\omega^{\alpha\beta\chi}\sigma_{\alpha\beta\chi}-3r_3\partial_{\beta}\omega^{\theta}_{\theta}\partial^{\chi}\omega^{\alpha\beta}_{\alpha}-3r_3\partial_{\chi}\omega^{\theta}_{\beta}\partial^{\chi}\omega^{\alpha\beta}_{\alpha}-3r_3\partial_{\alpha}\omega^{\alpha\beta\iota}_{\iota}\partial_{\theta}\omega^{\alpha\beta}_{\beta}+6r_3\partial^{\iota}\omega^{\alpha\beta}_{\alpha}\partial_{\theta}\omega^{\theta}_{\beta}+3r_3\partial_{\alpha}\omega^{\alpha\beta\iota}_{\iota}\partial_{\theta}\omega^{\alpha\beta}_{\beta}+6r_3\partial^{\iota}\omega^{\alpha\beta}_{\alpha}\partial_{\theta}\omega^{\theta}_{\beta}+4t_2\omega_{\iota\theta\alpha}\partial^{\theta}f^{a\iota}+2t_2\partial_{a\iota}f_{\theta}^{\theta}f^{a\iota}-t_2\partial_{a\iota}f_{\theta\iota}^{\theta}f^{a\iota}-t_2\partial_{\theta\iota}f_{\iota\alpha}^{\theta}f^{a\iota}-4t_2\omega_{a\theta\iota}(\omega^{a\iota\theta}+\partial^{\theta}f^{a\iota})+2t_2\omega_{a\iota\theta}(\omega^{a\iota\theta}+2\partial^{\theta}f^{a\iota})+8r_2\partial_{\beta}\omega_{a\iota\theta}\partial^{\theta}\omega^{\alpha\beta\iota}-4r_2\partial_{\beta}\omega_{\alpha\theta\iota}\partial^{\theta}\omega^{\alpha\beta\iota}+4r_2\partial_{\beta}\omega_{\iota\theta\alpha}\partial^{\theta}\omega^{\alpha\beta\iota}-24r_3\partial_{\beta}\omega_{\iota\theta\alpha}\partial^{\theta}\omega^{\alpha\beta\iota}-2r_2\partial_{\iota}\omega_{a\theta\theta}\partial^{\theta}\omega^{\alpha\beta\iota}+2r_2\partial_{\theta}\omega_{a\theta\iota}\partial^{\theta}\omega^{\alpha\beta\iota}-4r_2\partial_{\theta}\omega_{a\iota\beta}\partial^{\theta}\omega^{\alpha\beta\iota}+6r_5\partial_{\iota}\omega^{\kappa}_{\theta}\partial^{\theta}\omega^{a\iota}_{\alpha}-6r_5\partial_{\theta}\omega^{\kappa}_{\iota}\partial^{\theta}\omega^{a\iota}_{\alpha}-6r_5\partial_{\alpha}\omega^{a\iota\theta}\partial_{\kappa}\omega^{\kappa}_{\iota}+12r_5\partial^{\theta}\omega^{a\iota}_{\alpha}\partial_{\kappa}\omega^{\kappa}_{\iota}+6r_5\partial_{\alpha}\omega^{a\iota\theta}\partial_{\kappa}\omega^{\kappa}_{\iota}-12r_5\partial^{\theta}\omega^{a\iota}_{\alpha}\partial_{\kappa}\omega^{\kappa}_{\theta}\big)[t,x,y,z]dzdydxdt$	

$\sigma_{1+}^{\#1\alpha\beta}$	$\sigma_{1+}^{\#2\alpha\beta}$	$\tau_{1+}^{\#1\alpha\beta}$	$\sigma_{1-}^{\#1\alpha}$	$\sigma_{1-}^{\#2\alpha}$	$\tau_{1-}^{\#1\alpha}$	$\tau_{1-}^{\#2\alpha}$
$\frac{1}{k^2(2r_3+r_5)}$	$-\frac{\sqrt{2}}{k^2(1+k^2)(2r_3+r_5)}$	$-\frac{i\sqrt{2}}{k(1+k^2)(2r_3+r_5)}$	0	0	0	0
$-\frac{\sqrt{2}}{k^2(1+k^2)(2r_3+r_5)}$	$\frac{3k^2(2r_3+r_5)+2t_2}{(k+k^3)^2(2r_3+r_5)t_2}$	$\frac{i(3k^2(2r_3+r_5)+2t_2)}{k(1+k^2)^2(2r_3+r_5)t_2}$	0	0	0	0
$\frac{i\sqrt{2}}{k(1+k^2)(2r_3+r_5)}$	$-\frac{i(3k^2(2r_3+r_5)+2t_2)}{k(1+k^2)^2(2r_3+r_5)t_2}$	$\frac{3k^2(2r_3+r_5)+2t_2}{(1+k^2)^2(2r_3+r_5)t_2}$	0	0	0	0
0	0	0	$\frac{2}{k^2(r_3+2r_5)}$	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

$\omega_{1+}^{\#1\alpha\beta}$	$\omega_{1+}^{\#2\alpha\beta}$	$f_{1+}^{\#1\alpha\beta}$	$\omega_{1-}^{\#1\alpha}$	$\omega_{1-}^{\#2\alpha}$	$f_{1-}^{\#1\alpha}$	$f_{1-}^{\#2\alpha}$
$k^2(2r_3+r_5)+\frac{2t_2}{3}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{1}{3}i\sqrt{2}kt_2$	0	0	0	0
$\frac{\sqrt{2}t_2}{3}$	$\frac{t_2}{3}$	$\frac{ikt_2}{3}$	0	0	0	0
$-\frac{1}{3}i\sqrt{2}kt_2$	$-\frac{1}{3}ikt_2$	$\frac{k^2t_2}{3}$	0	0	0	0
0	0	0	$\frac{1}{2}k^2(r_3+2r_5)$	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

$\omega_{2+}^{\#1\alpha\beta}$	$f_{2+}^{\#1\alpha\beta}$	$\omega_{2-}^{\#1\alpha\beta\chi}$
$-\frac{3k^2r_3}{2}$	0	0
0	0	0
0	0	0
$\frac{1}{k^2r_2+t_2}$	0	0

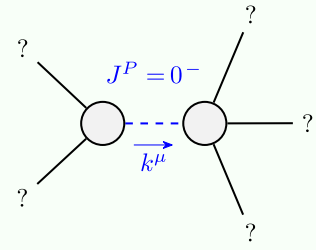
$\sigma_{0+}^{\#1\alpha}$	$\tau_{0+}^{\#1\alpha}$	$\tau_{0+}^{\#2\alpha}$	$\sigma_{0+}^{\#1\alpha}$
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

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

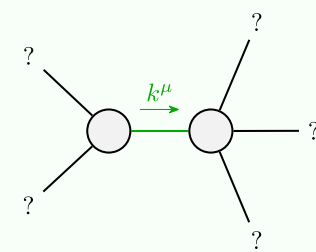
$\omega_0^{\#1\alpha}$	$f_0^{\#1\alpha}$	$\omega_0^{\#1\alpha}$
0	0	0
0	0	0
0	0	0
0	0	$k^2r_2+t_2$

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

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



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

Unitarity conditions

$r_2 < 0 \& \& r_3 < 0 \& \& r_5 < -\frac{r_3}{2} \& \& t_2 > 0 \parallel r_2 < 0 \& \& r_3 < 0 \& \& r_5 > -2r_3 \& \& t_2 > 0 \parallel r_2 < 0 \& \& r_3 > 0 \& \& -2r_3 < r_5 < -\frac{r_3}{2} \& \& t_2 > 0$