

Particle spectrograph

Wave operator and propagator

Source constraints		
SO(3) irreps	Fundamental fields	Multiplicities
$\tau_{0+}^{\#2} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == 0$	1
$\tau_{0+}^{\#1} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha_\alpha$	1
$\sigma_{0+}^{\#1} == 0$	$\partial_\beta \sigma^{\alpha\beta}_\alpha == 0$	1
$\tau_{1+}^{\#2\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta}$	3
$\tau_{1+}^{\#1\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\beta\alpha}$	3
$\sigma_{1+}^{\#2\alpha} == 0$	$\partial_\chi \partial_\beta \sigma^{\alpha\beta\chi} == 0$	3
$\tau_{1+}^{\#1\alpha\beta} + i k \sigma_{1+}^{\#1\alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} +$ $\partial_\beta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + \partial_\alpha \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha} ==$ $\partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\chi \tau^{\beta\alpha} +$ $\partial_\beta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + \partial_\alpha \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta}$	3
$\sigma_{1+}^{\#1\alpha\beta} == \sigma_{1+}^{\#2\alpha\beta}$	$3 \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} +$ $2 \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} ==$ $3 \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha}$	3
$\sigma_{2+}^{\#1\alpha\beta\chi} == 0$	$3 \partial_\epsilon \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\delta\epsilon} + 3 \partial_\epsilon \partial^\epsilon \partial_\chi \partial^\alpha \sigma^{\beta\delta}_\delta +$ $2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\delta \sigma^{\alpha\chi\delta} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\delta \sigma^{\alpha\delta\chi} +$ $2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\delta \sigma^{\beta\chi\delta\alpha} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\delta \sigma^{\alpha\beta\delta} +$ $2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\delta \sigma^{\alpha\delta\beta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\delta \sigma^{\beta\chi\alpha} +$ $3 \eta^{\beta\chi} \partial_\theta \partial^\theta \partial_\epsilon \partial^\alpha \sigma^{\delta\epsilon}_\delta +$ $3 \eta^{\alpha\chi} \partial_\theta \partial^\theta \partial_\epsilon \partial_\delta \sigma^{\beta\delta\epsilon} +$ $3 \eta^{\beta\chi} \partial_\theta \partial^\theta \partial_\epsilon \partial^\alpha \sigma^{\alpha\delta}_\delta ==$ $3 \partial_\epsilon \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\delta\epsilon} + 3 \partial_\epsilon \partial^\epsilon \partial_\chi \partial^\alpha \sigma^{\beta\delta}_\delta +$ $2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\delta \sigma^{\beta\chi\delta} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\delta \sigma^{\beta\delta\chi} +$ $2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\delta \sigma^{\chi\delta\beta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\delta \sigma^{\beta\delta\alpha} +$ $4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\delta \sigma^{\alpha\beta\chi} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\delta \sigma^{\alpha\chi\beta} +$ $3 \eta^{\alpha\chi} \partial_\theta \partial^\theta \partial_\epsilon \partial_\delta \sigma^{\delta\epsilon}_\delta +$ $3 \eta^{\beta\chi} \partial_\theta \partial^\theta \partial_\epsilon \partial_\delta \sigma^{\alpha\delta\epsilon} +$ $3 \eta^{\alpha\chi} \partial_\theta \partial^\theta \partial_\epsilon \partial^\beta \sigma^{\beta\delta}_\delta$	5
$\tau_{2+}^{\#1\alpha\beta} == 0$	$4 \partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2 \partial_\delta \partial^\delta \partial^\beta \partial^\alpha \tau^\chi_\chi +$ $3 \partial_\delta \partial^\delta \partial_\chi \partial_\chi \tau^{\alpha\beta} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\beta\alpha} +$ $2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} ==$ $3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta} +$ $3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\alpha\chi} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} +$ $2 \eta^{\alpha\beta} \partial_\epsilon \partial_\delta \partial_\delta \tau^\chi_\chi$	5
Total constraints/gauge generators:		28

Quadratic (free) action
$S == \iiint (\frac{1}{6} (6 f^{\alpha\beta} \tau_{\alpha\beta} + 6 \mathcal{A}^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - 15 r_3 \partial_\beta \mathcal{A}_{,\beta}^\theta \partial_\theta \mathcal{A}^{\alpha\beta}_\alpha + 9 r_3 \partial_\beta \mathcal{A}_{,\beta}^\theta \partial^\theta \mathcal{A}^{\alpha\beta}_\alpha + 9 r_3 \partial_\beta \mathcal{A}_{,\beta}^\theta \partial^\theta \mathcal{A}^{\alpha\beta}_\alpha -$ $\partial^\theta \mathcal{A}^{\alpha\beta}_\alpha + 9 r_3 \partial_\alpha \mathcal{A}^{\alpha\beta\iota} \partial_\theta \mathcal{A}_{,\beta}^\theta \partial_\theta \mathcal{A}^{\alpha\beta}_\beta - 18 r_3 \partial_\iota \mathcal{A}^{\alpha\beta}_\alpha \partial_\theta \mathcal{A}_{,\beta}^\theta \partial^\theta f^{\alpha\iota} -$ $15 r_3 \partial_\alpha \mathcal{A}^{\alpha\beta\iota} \partial_\theta \mathcal{A}_{,\beta}^\theta \partial_\theta \mathcal{A}^{\alpha\beta}_\beta + 30 r_3 \partial_\iota \mathcal{A}^{\alpha\beta}_\alpha \partial_\theta \mathcal{A}_{,\beta}^\theta \partial^\theta f^{\alpha\iota} -$ $4 t_2 \mathcal{A}_{,\theta\alpha} \partial^\theta f^{\alpha\iota} + 2 t_2 \partial_\omega f_{,\theta} \partial^\theta f^{\alpha\iota} - t_2 \partial_\omega f_{,\alpha} \partial^\theta f^{\alpha\iota} \partial_\theta \partial^\theta f^{\alpha\iota} -$ $t_2 \partial_\iota f_{,\alpha\theta} \partial^\theta f^{\alpha\iota} + t_2 \partial_\theta f_{,\alpha\iota} \partial^\theta f^{\alpha\iota} - t_2 \partial_\theta f_{,\alpha\iota} \partial^\theta f^{\alpha\iota} - 4 t_2$ $\mathcal{A}_{\alpha\theta\iota} (\mathcal{A}^{\alpha\iota\theta} + \partial^\theta f^{\alpha\iota}) + 2 t_2 \mathcal{A}_{\alpha\theta\iota} (\mathcal{A}^{\alpha\iota\theta} + 2 \partial^\theta f^{\alpha\iota}) +$ $8 r_2 \partial_\beta \mathcal{A}_{\alpha\theta\iota} \partial^\theta \mathcal{A}^{\alpha\beta\iota} - 4 r_2 \partial_\beta \mathcal{A}_{\alpha\theta\iota} \partial^\theta \mathcal{A}^{\alpha\beta\iota} +$ $4 r_2 \partial_\beta \mathcal{A}_{,\theta\alpha} \partial^\theta \mathcal{A}^{\alpha\beta\iota} - 24 r_3 \partial_\beta \mathcal{A}_{,\theta\alpha} \partial^\theta \mathcal{A}^{\alpha\beta\iota} -$ $2 r_2 \partial_\iota \mathcal{A}_{\alpha\theta\beta} \partial^\theta \mathcal{A}^{\alpha\beta\iota} + 2 r_2 \partial_\theta \mathcal{A}_{\alpha\beta\iota} \partial^\theta \mathcal{A}^{\alpha\beta\iota} -$ $4 r_2 \partial_\theta \mathcal{A}_{\alpha\iota\beta} \partial^\theta \mathcal{A}^{\alpha\beta\iota})) [t, x, y, z] dz dy dx dt$

$\mathcal{A}_{1+}^{\#1} + \alpha\beta$	$\mathcal{A}_{1+}^{\#2}$	$\mathcal{A}_{1+}^{\#1\alpha\beta}$	$f_{1+}^{\#1\alpha\beta}$	$\mathcal{A}_{1+}^{\#1\alpha}$	$\mathcal{A}_{1+}^{\#2\alpha}$	$f_{1+}^{\#1\alpha}$	$f_{1+}^{\#2\alpha}$
$\frac{2t_2}{3}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{1}{3}i\sqrt{2}kt_2$	0	0	0	0	0
$\mathcal{A}_{1+}^{\#2} + \alpha\beta$	$\frac{t_2}{3}$	$\frac{ikt_2}{3}$	0	0	0	0	0
$f_{1+}^{\#1} + \alpha\beta$	$-\frac{1}{3}i\sqrt{2}kt_2$	$-\frac{1}{3}i\sqrt{2}kt_2$	0	0	0	0	0
$\mathcal{A}_{1+}^{\#1\alpha}$	0	0	$-\frac{3k^2r_3}{2}$	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

$\sigma_{1+}^{\#1} + \alpha\beta$	$\frac{6}{(3+k^2)^2t_2}$	$\frac{3\sqrt{2}}{(3+k^2)^2t_2}$	$\frac{3i\sqrt{2}k}{(3+k^2)^2t_2}$	$\frac{1}{3}i\sqrt{2}kt_2$	$\sigma_{1+}^{\#1\alpha\beta}$	$\tau_{1+}^{\#1\alpha\beta}$	$\sigma_{1+}^{\#2\alpha}$	$\tau_{1+}^{\#1\alpha}$	$\tau_{1+}^{\#2\alpha}$
$\sigma_{1+}^{\#2} + \alpha\beta$	$\frac{3\sqrt{2}}{(3+k^2)^2t_2}$	$\frac{3}{(3+k^2)^2t_2}$	$\frac{3ik}{(3+k^2)^2t_2}$	$\frac{3i\sqrt{2}k}{(3+k^2)^2t_2}$	0	0	0	0	0
$\tau_{1+}^{\#1} + \alpha\beta$	$-\frac{3i\sqrt{2}k}{(3+k^2)^2t_2}$	$-\frac{3ik}{(3+k^2)^2t_2}$	$-\frac{3k^2}{(3+k^2)^2t_2}$	$-\frac{3k^2r_3}{2}$	0	0	0	0	0
$\sigma_{1+}^{\#1} + \alpha$	0	0	0	$-\frac{2}{3k^2r_3}$	0	0	0	0	0
$\sigma_{1+}^{\#2} + \alpha$	0	0	0	0	0	0	0	0	0
$\tau_{1+}^{\#1} + \alpha$	0	0	0	0	0	0	0	0	0
$\tau_{1+}^{\#2} + \alpha$	0	0	0	0	0	0	0	0	0

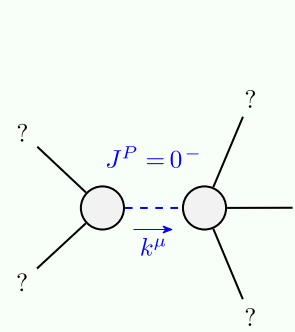
$\sigma_{0+}^{\#1} + \alpha\beta$	$\mathcal{A}_{2+}^{\#1} + \alpha\beta$	$f_{2+}^{\#1} + \alpha\beta$	$\mathcal{A}_{2+}^{\#1\alpha\beta\chi}$
$-\frac{3k^2r_3}{2}$	0	0	0
0	0	0	0
0	0	0	0

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

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

$\mathcal{A}_{0+}^{\#1} + \alpha\beta$	$f_{0+}^{\#1} + \alpha\beta$	$f_{0+}^{\#2} + \alpha\beta$	$\mathcal{A}_{0+}^{\#1\alpha\beta\chi}$
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$k^2r_2+t_2$

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

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