

Particle spectrograph

Wave operator and propagator

Source constraints			
SO(3) irreps	Fundamental fields		Multiplicities
$\tau^{#2}_{0^+} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == 0$		1
$\tau^{#1}_{0^+} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha_\alpha$		1
$\sigma^{#1}_{0^+} == 0$	$\partial_\beta \sigma^{\alpha\beta}_\alpha == 0$		1
$\tau^{#2\alpha}_1 + 2\,i\,k\,\sigma^{#1\alpha}_1 == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} +$ $2\,(\partial_\delta \partial^\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi}_\beta - \partial_\delta \partial^\delta \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi} +$ $\partial_\delta \partial^\delta \partial_\chi \partial^\chi \sigma^{\alpha\beta}_\beta) == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta}$		3
$\tau^{#1\alpha}_1 == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\beta\alpha}$		3
$\sigma^{#1\alpha}_1 == \sigma^{#2\alpha}_1$	$\partial_\chi \partial^\alpha \sigma^{\beta\chi}_\beta + \partial_\chi \partial^\chi \sigma^{\alpha\beta}_\beta == 0$		3
$\tau^{#1\alpha\beta}_1 + i\,k\,\sigma^{#2\alpha\beta}_1 == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} +$ $2\,\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 2\,\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} ==$ $\partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} +$ $\partial_\chi \partial^\chi \tau^{\beta\alpha} + 2\,\partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta}$		3
$\tau^{#1\alpha\beta}_2 - 2\,i\,k\,\sigma^{#1\alpha\beta}_2 == 0$	$-i\,(4\,\partial_\delta \partial_\chi \partial_\beta \partial^\alpha \tau^{\chi\delta} + 2\,\partial_\delta \partial^\delta \partial_\beta \partial^\alpha \tau^\chi_\chi -$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} - 3\,\partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta} -$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial_\beta \tau^{\alpha\chi} - 3\,\partial_\delta \partial^\delta \partial_\chi \partial_\beta \tau^{\chi\alpha} +$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\alpha\beta} + 3\,\partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\beta\alpha} +$ $4\,i\,k^\chi \partial_\epsilon \partial_\chi \partial_\beta \partial^\alpha \sigma^{\delta\epsilon}_\delta -$ $6\,i\,k^\chi \partial_\epsilon \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\delta\epsilon}_\delta -$ $6\,i\,k^\chi \partial_\epsilon \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\delta\epsilon}_\epsilon +$ $2\,\eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} +$ $6\,i\,k^\chi \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\alpha\delta\beta}_\beta +$ $6\,i\,k^\chi \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\beta\delta\alpha}_\alpha -$ $2\,\eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \tau^\chi_\chi -$ $4\,i\,\eta^{\alpha\beta} \,k^\chi \partial_\phi \partial^\phi \partial_\epsilon \partial_\chi \sigma^{\delta\epsilon}_\delta) == 0$	5	
Total constraints/gauge generators:			20

Quadratic (free) action

$$S = \iiint \Big(\frac{1}{6} \, (2\,t_1\,\omega^\alpha_\alpha\,\omega^\theta_{\theta} + 6\,f^{\alpha\beta}\,\tau_{\alpha\beta} + 6\,\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} - 4\,t_1\,\omega^\theta_\alpha\,\partial_\theta f^{\alpha\chi} +$$

$$4\,t_1\,\omega^\theta_{\theta}\,\partial_\theta f^\alpha_\alpha - 2\,t_1\,\partial_\theta f^\theta_\theta\,\partial_\theta f^\alpha_\alpha - 2\,t_1\,\partial_\theta f^{\alpha\chi}_\alpha\,\partial_\theta f^\theta_\chi +$$

$$4\,t_1\,\partial_\theta f^\alpha_\alpha\,\partial_\theta f^\theta_{\theta} - 6\,t_1\,\partial_\alpha f_{\theta}\,\partial^\theta f^{\alpha\chi}_\chi - 3\,t_1\,\partial_\alpha f_{\theta}\,\partial^\theta f^{\alpha\chi}_\chi +$$

$$3\,t_1\,\partial_\theta f_{\alpha\theta}\,\partial^\theta f^{\alpha\chi}_\chi + 3\,t_1\,\partial_\theta f_{\alpha\chi}\,\partial^\theta f^{\alpha\chi}_\chi + 3\,t_1\,\partial_\theta f_{\alpha}\,\partial^\theta f^{\alpha\chi}_\chi +$$

$$6\,t_1\,\omega_{\alpha\theta\chi}\,(\omega^{\alpha\chi\theta} + 2\,\partial^\theta f^{\alpha\chi}_\chi) + 8\,r_2\,\partial_\beta \omega_{\alpha\theta\beta}\,\partial^\theta \omega^{\alpha\beta\chi}_\chi -$$

$$4\,r_2\,\partial_\beta \omega_{\alpha\theta\chi}\,\partial^\theta \omega^{\alpha\beta\chi}_\chi + 4\,r_2\,\partial_\beta \omega_{\theta\alpha\beta}\,\partial^\theta \omega^{\alpha\beta\chi}_\chi -$$

$$2\,r_2\,\partial_\theta \omega_{\alpha\beta\theta}\,\partial^\theta \omega^{\alpha\beta\chi}_\chi + 2\,r_2\,\partial_\theta \omega_{\alpha\beta\chi}\,\partial^\theta \omega^{\alpha\beta\chi}_\chi -$$

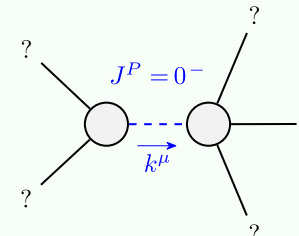
$$4\,r_2\,\partial_\theta \omega_{\alpha\theta\beta}\,\partial^\theta \omega^{\alpha\beta\chi}_\chi) [t,\,x,\,y,\,z] dz\,dy\,dx\,dt$$

$\sigma^{#1}_1 + \alpha\beta$	$\sigma^{#2}_1 + \alpha\beta$	$\tau^{#1}_1 + \alpha\beta$	$\sigma^{#1}_1 - \alpha$	$\sigma^{#2}_1 - \alpha$	$\tau^{#1}_1 - \alpha$	$\tau^{#2}_1 - \alpha$
0	$-\frac{\sqrt{2}}{t_1 + k^2} t_1$	$-\frac{i\sqrt{2}k}{t_1 + k^2} t_1$	0	0	0	0
$\sigma^{#2}_1 + \alpha\beta$	$-\frac{\sqrt{2}}{t_1 + k^2} t_1$	$\frac{ik}{(1 + k^2)^2} t_1$	0	0	0	0
$\tau^{#1}_1 + \alpha\beta$	$\frac{i\sqrt{2}k}{t_1 + k^2} t_1$	$-\frac{k^2}{(1 + k^2)^2} t_1$	0	0	0	0
$\sigma^{#1}_1 - \alpha$	0	0	$\frac{6}{(3 + 4k^2)^2} t_1$	$\frac{6\sqrt{2}}{(3 + 4k^2)^2} t_1$	0	$\frac{12ik}{(3 + 4k^2)^2} t_1$
$\sigma^{#2}_1 - \alpha$	0	0	$\frac{6\sqrt{2}}{(3 + 4k^2)^2} t_1$	$\frac{12}{(3 + 4k^2)^2} t_1$	0	$\frac{12i\sqrt{2}k}{(3 + 4k^2)^2} t_1$
$\tau^{#1}_1 - \alpha$	0	0	0	0	0	0
$\tau^{#2}_1 - \alpha$	0	0	$-\frac{12ik}{(3 + 4k^2)^2} t_1$	$-\frac{12i\sqrt{2}k}{(3 + 4k^2)^2} t_1$	0	$\frac{24k^2}{(3 + 4k^2)^2} t_1$

$\omega^{#1}_1 + \alpha\beta$	$\omega^{#2}_1 + \alpha\beta$	$f^{#1}_1 + \alpha\beta$	$\omega^{#1}_1 - \alpha$	$\omega^{#2}_1 - \alpha$	$f^{#1}_1 - \alpha$	$f^{#2}_1 - \alpha$
$-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$\frac{ikt_1}{\sqrt{2}}$	0	0	0	0	0	0
0	0	0	$\frac{t_1}{6}$	$\frac{t_1}{3\sqrt{2}}$	0	$\frac{ikt_1}{3}$
0	0	0	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	0	$\frac{1}{3}i\sqrt{2}kt_1$
0	0	0	0	0	0	0
0	0	0	$-\frac{1}{3}ikt_1$	$-\frac{1}{3}i\sqrt{2}kt_1$	0	$\frac{2k^2t_1}{3}$

$\sigma^{#1}_2 + \alpha\beta$	$\tau^{#1}_2 + \alpha\beta$	$\sigma^{#1}_2 - \alpha\beta\chi$
$\frac{2}{(1 + 2k^2)^2} t_1$	$-\frac{2i\sqrt{2}k}{(1 + 2k^2)^2} t_1$	0
$\frac{2i\sqrt{2}k}{(1 + 2k^2)^2} t_1$	$\frac{4k^2}{(1 + 2k^2)^2} t_1$	0
0	0	$\frac{2}{t_1}$
$\omega^{#1}_2 + \alpha\beta$	$f^{#1}_2 + \alpha\beta$	$\omega^{#1}_2 - \alpha$
$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	0
$\frac{ikt_1}{\sqrt{2}}$	k^2t_1	0
0	0	$\frac{t_1}{2}$
$\omega^{#1}_0 + \alpha$	$f^{#1}_0 + \alpha$	$\omega^{#1}_0 - \alpha$
0	0	0
$f^{#1}_0 + \alpha$	0	0
$\omega^{#1}_0 - \alpha$	0	$k^2r_2 - t_1$
$\sigma^{#1}_0 + \alpha$	$\tau^{#1}_0 + \alpha$	$\sigma^{#1}_0 - \alpha$
0	0	0
$\tau^{#1}_0 + \alpha$	0	0
$\tau^{#2}_0 + \alpha$	0	0
$\sigma^{#1}_0 - \alpha$	0	$\frac{1}{k^2r_2 - t_1}$

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{r_2} > 0$
Polarisations:	1
Square mass:	$\frac{t_1}{r_2} > 0$
Spin:	0
Parity:	Odd

(no massless particles)

Unitarity conditions

$r_2 < 0 \ \&\& \ t_1 < 0$