

Particle spectrograph

Wave operator and propagator

Source constraints			Fundamental fields	Multiplicities
SO(3) irreps				
$\tau_0^{\#2} == 0$			$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == 0$	1
$\tau_0^{\#1} == 0$			$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha_\alpha$	1
$\sigma_0^{\#1} == 0$			xAct`xTensor`Private`Reconstruct[Symmetry[4, -i \partial^{\bullet 1} \sigma^{\bullet 2} \bullet^{\bullet 3} \bullet^{\bullet 4}, {\bullet 1 \to a, \bullet 2 \to -a, \bullet 3 \to b, \bullet 4 \to -b}. StrongGenSet[{2, 3}, GenSet[-(2,3)]]]. {-1, {a, -a, b, -b}}][{1, 3, 5, 2}]] == 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
$\tau_1^{\#1\alpha\beta} + i k \sigma_1^{\#2\alpha\beta} == 0$			$\partial_\chi \partial_\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^\chi_\alpha + \partial_\chi \partial^\chi \tau^{\alpha\beta} + 2 \partial_\delta \partial_\chi \partial^\delta \sigma^{\alpha\beta\chi} == \partial_\chi \partial^\chi \tau^{\beta\alpha} + \partial_\chi \partial^\beta \tau^\chi_\alpha + 2 \partial_\delta \partial_\chi \partial^\delta \sigma^{\alpha\chi\delta}$	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^\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^\delta \sigma^{\beta\chi\alpha} + 3 \eta^{\beta\chi} \partial_\phi \partial^\phi \partial_\epsilon \sigma^{\alpha\delta\epsilon}_\delta + 3 \eta^{\alpha\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial_\delta \sigma^{\beta\delta\epsilon} + 3 \eta^{\beta\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial^\delta \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^\beta \sigma^{\alpha\delta}_\delta + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\alpha \sigma^{\beta\chi\delta} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\alpha \sigma^{\beta\delta\chi} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\alpha \sigma^{\chi\delta\beta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\chi \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_\phi \partial^\phi \partial_\epsilon \partial^\delta \sigma^{\delta\epsilon}_\delta + 3 \eta^{\beta\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial_\delta \sigma^{\alpha\delta\epsilon} + 3 \eta^{\alpha\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial^\delta \sigma^{\beta\delta}_\delta$	5
$\tau_2^{\#1\alpha\beta} == 0$			$4 \partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2 \partial_\delta \partial^\delta \partial^\beta \partial^\alpha \tau^\chi_\chi + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\alpha\beta} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\beta\alpha} + 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} == 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} + 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\chi \tau^\chi_\chi$	5
$\sigma_2^{\#1\alpha\beta} == 0$			$3 \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 3 \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\chi\delta}_\chi == 2 \partial_\delta \partial^\delta \partial^\alpha \sigma^{\chi\delta}_\chi + 3 (\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha})$	5
Total constraints/gauge generators:				30

Quadratic (free) action	
$S = \int \int \int \int \Big(\frac{1}{6} (6 f^{\alpha\beta} \tau_{\alpha\beta} + 6 \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + 4 t_2 \omega_{\theta\alpha} \partial^\theta f^{\alpha\chi} + 2 t_2 \partial_\alpha f_{\theta\beta} \partial^\theta f^{\alpha\chi} - t_2 \partial_\alpha f_{\theta\chi} \partial^\theta f^{\alpha\chi} - t_2 \partial_\beta f_{\alpha\theta} \partial^\theta f^{\alpha\chi} + t_2 \partial_\theta f_{\alpha\chi} \partial^\theta f^{\alpha\chi} - t_2 \partial_\theta f_{\alpha\chi} \partial^\theta f^{\alpha\chi} - 4 t_2 \omega_{\alpha\theta\chi} (\omega^{\alpha\theta\beta} + 2 \partial^\theta f^{\alpha\chi}) + 8 r_2 \partial_\beta \omega_{\alpha\theta\beta} \partial^\theta \omega^{\alpha\beta\chi} - 2 t_2 \omega_{\alpha\theta\beta} (\omega^{\alpha\theta\beta} + 2 \partial^\theta f^{\alpha\chi}) + 4 r_2 \partial_\beta \omega_{\alpha\theta\beta} \partial^\theta \omega^{\alpha\beta\chi} - 4 r_2 \partial_\beta \omega_{\alpha\theta\beta} \partial^\theta \omega^{\alpha\beta\chi} + 4 r_2 \partial_\beta \omega_{\alpha\theta\beta} \partial^\theta \omega^{\alpha\beta\chi} - 6 r_5 \partial_\theta \omega_{\alpha\theta\beta} \partial^\theta \omega^{\alpha\beta\chi} + 6 r_5 \partial_\theta \omega_{\alpha\theta\beta} \partial^\theta \omega^{\alpha\beta\chi} - 12 r_5 \partial^\theta \omega^{\alpha\chi}_\alpha \partial_\chi \omega^{\alpha\theta}_\theta + 6 r_5 \partial_\alpha \omega^{\alpha\theta\beta} \partial_\chi \omega^{\alpha\theta\beta}_\chi - 12 r_5 \partial^\theta \omega^{\alpha\chi}_\alpha \partial_\chi \omega^{\alpha\theta}_\theta) \Big) [t, x, y, z] dz dy dx dt$	

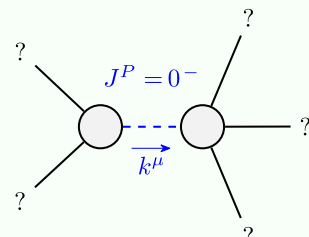
$\sigma_1^{\#1} + \alpha\beta$	$\sigma_1^{\#2}$	$\tau_1^{\#1}$	$\sigma_1^{\#1}$	$\sigma_1^{\#2}$	$\tau_1^{\#1}$	$\tau_1^{\#2}$
$\frac{1}{k^2 r_5}$	$-\frac{\sqrt{2}}{k^2 r_5 + k^4 r_5}$	$-\frac{i \sqrt{2}}{k r_5 + k^3 r_5}$	0	0	0	0
$\sigma_1^{\#2} + \alpha\beta$	$-\frac{\sqrt{2}}{k^2 r_5 + k^4 r_5}$	$\frac{i (3 k^2 r_5 + 2 t_2)}{(k + k^3)^2 r_5 t_2}$	0	0	0	0
$\tau_1^{\#1} + \alpha\beta$	$\frac{i \sqrt{2}}{k r_5 + k^3 r_5}$	$-\frac{i (3 k^2 r_5 + 2 t_2)}{k (1 + k^2)^2 r_5 t_2}$	0	0	0	0
$\sigma_1^{\#1} + \alpha$	0	0	$\frac{1}{k^2 r_5}$	0	0	0
$\sigma_1^{\#2} + \alpha$	0	0	0	0	0	0
$\tau_1^{\#1} + \alpha$	0	0	0	0	0	0
$\tau_1^{\#2} + \alpha$	0	0	0	0	0	0

$\omega_1^{\#1} + \alpha\beta$	$\omega_1^{\#2}$	$f_1^{\#1}$	$\omega_1^{\#1}$	$\omega_1^{\#2}$	$f_1^{\#1}$	$f_1^{\#2}$
$k^2 r_5 + \frac{2 t_2}{3}$	$\frac{\sqrt{2} t_2}{3}$	$\frac{1}{3} i \sqrt{2} k t_2$	0	0	0	0
$\omega_1^{\#2} + \alpha\beta$	$\frac{t_2}{3}$	$\frac{i k t_2}{3}$	0	0	0	0
$f_1^{\#1} + \alpha\beta$	$-\frac{1}{3} i \sqrt{2} k t_2$	$-\frac{k^2 t_2}{3}$	0	0	0	0
$\omega_1^{\#1} + \alpha$	0	0	$k^2 r_5$	0	0	0
$\omega_1^{\#2} + \alpha$	0	0	0	0	0	0
$f_1^{\#1} + \alpha$	0	0	0	0	0	0
$f_1^{\#2} + \alpha$	0	0	0	0	0	0

$\omega_2^{\#1} + \alpha\beta$	$\omega_2^{\#2}$	$f_2^{\#1}$	$\omega_2^{\#1}$	$\omega_2^{\#2}$	$f_2^{\#1}$	$f_2^{\#2}$
0	0	0	0	0	0	0
$\omega_2^{\#1} + \alpha\beta$	0	0	0	0	0	0
$\omega_2^{\#1} + \alpha\beta\chi$	0	0	0	0	0	0

$\sigma_0^{\#1} + \alpha$	$\sigma_0^{\#1}$	$\tau_0^{\#1}$	$\tau_0^{\#2}$	$\sigma_0^{\#1}$
0	0	0	0	0
$\tau_0^{\#1} + \alpha$	0	0	0	0
$\tau_0^{\#2} + \alpha$	0	0	0	0
$\sigma_0^{\#1} + \alpha$	0	0	0	$\frac{1}{k^2 r_2 + t_2}$

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{t_2} > 0$
Polarisations:	1
Square mass:	$-\frac{t_2}{2} > 0$
Spin:	0
Parity:	Odd

(selected ssejssew oN)

Unitarity conditions

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