

Particle spectrograph

Wave operator and propagator

$\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1+}^{\#2} \dagger^{\alpha\beta}$	$\tau_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1-}^{\#1} \dagger^{\alpha}$	$\sigma_{1-}^{\#2} \dagger^{\alpha}$	$\tau_{1-}^{\#1} \dagger^{\alpha}$	$\tau_{1-}^{\#2} \dagger^{\alpha}$
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
$-\frac{\sqrt{2}}{t_1+k^2}t_1$	$\frac{1}{(1+k^2)^2}t_1$	$\frac{ik}{(1+k^2)^2}t_1$	0	0	0	0
$\frac{i\sqrt{2}k}{t_1+k^2}t_1$	$-\frac{ik}{(1+k^2)^2}t_1$	$\frac{k^2}{(1+k^2)^2}t_1$	0	0	0	0
0	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2}t_1$	0	$\frac{2ik}{t_1+2k^2}t_1$
0	0	0	$\frac{\sqrt{2}}{t_1+2k^2}t_1$	$\frac{2k^2r_1+t_1}{(t_1+2k^2t_1)^2}$	0	$\frac{i\sqrt{2}k(2k^2r_1+t_1)}{(t_1+2k^2t_1)^2}$
0	0	0	0	0	0	0
0	0	0	$-\frac{2ik}{t_1+2k^2}t_1$	$-\frac{i\sqrt{2}k(2k^2r_1+t_1)}{(t_1+2k^2t_1)^2}$	0	$\frac{2k^2(2k^2r_1+t_1)}{(t_1+2k^2t_1)^2}$

Quadratic (free) action

$$S=$$

$$\iiint [(f^{\alpha\beta} \tau_{\alpha\beta} + \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + \frac{1}{2} t_1 (2 \omega_{\alpha}^{\alpha i} \omega_{\theta}^{\theta} - 4 \omega_{\alpha}^{\theta} \partial_{\theta} f^{\alpha i} + 4 \omega_{\theta}^{\theta} \partial_{\theta} f^{\alpha}{}_{\alpha} - 2 \partial_{\theta} f^{\theta} \partial_{\theta} f^{\alpha}{}_{\alpha} - 2 \partial_{\theta} f^{\alpha i} \partial_{\theta} f^{\theta}{}_{\alpha} + 4 \partial_{\theta} f^{\alpha} \partial_{\theta} f^{\theta}{}_{\alpha} - 2 \partial_{\alpha} f_{\theta} \partial^{\theta} f^{\alpha i} - \partial_{\alpha} f_{\theta i} \partial^{\theta} f^{\alpha i} + \partial_{\theta} f_{\alpha\theta} \partial^{\theta} f^{\alpha i} + \partial_{\theta} f_{\alpha i} \partial^{\theta} f^{\alpha i} + \partial_{\theta} f_{i\alpha} \partial^{\theta} f^{\alpha i} + 2 \omega_{\alpha\theta i} (\omega^{\alpha i\theta} + 2 \partial^{\theta} f^{\alpha i})) - \frac{2}{3} r_1 (3 \partial_{\beta} \omega_{\theta}^{\theta} \partial' \omega_{\alpha}^{\alpha\beta} - 3 \partial_{\theta} \omega_{\beta}^{\theta} \partial' \omega_{\alpha}^{\alpha\beta} - 3 \partial_{\alpha} \omega^{\alpha\beta i} \partial_{\theta} \omega_{\beta}^{\theta} + 6 \partial' \omega_{\alpha}^{\alpha\beta} \partial_{\theta} \omega_{\beta}^{\theta} + 3 \partial_{\alpha} \omega^{\alpha\beta i} \partial_{\theta} \omega_{\theta}^{\theta} - 6 \partial' \omega_{\alpha}^{\alpha\beta} \partial_{\theta} \omega_{\theta}^{\theta} + 2 \partial_{\beta} \omega_{\alpha i \theta} \partial^{\theta} \omega^{\alpha\beta i} - \partial_{\beta} \omega_{\alpha\theta i} \partial^{\theta} \omega^{\alpha\beta i} + 4 \partial_{\beta} \omega_{\theta\alpha} \partial^{\theta} \omega^{\alpha\beta i} + \partial_{\theta} \omega_{\alpha\beta\theta} \partial^{\theta} \omega^{\alpha\beta i} - \partial_{\theta} \omega_{\alpha i \beta} \partial^{\theta} \omega^{\alpha\beta i}))][t, x, y, z] dz dy dx dt$$

$\omega_{1+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1+}^{\#2} \dagger^{\alpha\beta}$	$f_{1+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1-}^{\#1} \dagger^{\alpha}$	$\omega_{1-}^{\#2} \dagger^{\alpha}$	$f_{1-}^{\#1} \dagger^{\alpha}$	$f_{1-}^{\#2} \dagger^{\alpha}$
$-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	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	$-k^2r_1-\frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	0	$ikt_1$
0	0	0	$\frac{t_1}{\sqrt{2}}$	0	0	0
0	0	0	0	0	0	0
0	0	0	$-ikt_1$	0	0	0

$\omega_{2+}^{\#1} \dagger^{\alpha\beta}$	$f_{2+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{2-}^{\#1} \dagger^{\alpha\beta\chi}$
$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	0
$\frac{ikt_1}{\sqrt{2}}$	$k^2t_1$	0
0	0	$k^2r_1+\frac{t_1}{2}$

$\omega_{0+}^{\#1} \dagger$	$f_{0+}^{\#1} \dagger$	$f_{0+}^{\#2} \dagger$	$\omega_{0-}^{\#1} \dagger$
-t <sub>1</sub>	$i\sqrt{2}kt_1$	0	0
$-i\sqrt{2}kt_1$	-2k <sup>2</sup> t <sub>1</sub>	0	0
0	0	0	0
0	0	0	-t <sub>1</sub>

$\sigma_{0+}^{\#1} \dagger$	$\tau_{0+}^{\#1} \dagger$	$\tau_{0+}^{\#2} \dagger$	$\sigma_{0-}^{\#1} \dagger$
$-\frac{1}{(1+2k^2)^2}t_1$	$\frac{i\sqrt{2}k}{(1+2k^2)^2}t_1$	0	0
$\frac{i\sqrt{2}k}{(1+2k^2)^2}t_1$	$-\frac{2k^2}{(1+2k^2)^2}t_1$	0	0
0	0	0	0
0	0	0	$-\frac{1}{t_1}$

$\sigma_{2+}^{\#1} \dagger^{\alpha\beta}$	$\tau_{2+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{2-}^{\#1} \dagger^{\alpha\beta\chi}$
$\frac{2}{(1+2k^2)^2}t_1$	$-\frac{2i\sqrt{2}k}{(1+2k^2)^2}t_1$	0
$\frac{2i\sqrt{2}k}{(1+2k^2)^2}t_1$	$\frac{4k^2}{(1+2k^2)^2}t_1$	0
0	0	$\frac{2}{2k^2r_1+t_1}$

Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau_{0+}^{\#2} == 0$	1
$\tau_{0+}^{\#1} - 2ik\sigma_{0+}^{\#1} == 0$	1
$\tau_{1-}^{\#2\alpha} + 2ik\sigma_{1-}^{\#2\alpha} == 0$	3
$\tau_{1-}^{\#1\alpha} == 0$	3
$\tau_{1+}^{\#1\alpha\beta} + ik\sigma_{1+}^{\#2\alpha\beta} == 0$	3
$\tau_{2+}^{\#1\alpha\beta} - 2ik\sigma_{2+}^{\#1\alpha\beta} == 0$	5
Total constraints:	16

Massive and massless spectra

Massive particle

Pole residue:	$-\frac{1}{r_1} > 0$
Polarisations:	5
Square mass:	$-\frac{t_1}{2r_1} > 0$
Spin:	2
Parity:	Odd

(No massless particles)

Unitarity conditions

$r_1 < 0 \&\& t_1 > 0$