

Particle spectrograph

Wave operator and propagator

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

Quadratic (free) action

$$S=$$

$$\iiint\!\!\!\int(f^{\alpha\beta}\tau_{\alpha\beta}+\omega^{\alpha\beta\chi}\sigma_{\alpha\beta\chi}+\frac{1}{2}t_1(2\omega^{\alpha\iota}\omega_{\alpha\iota}{}^{\theta}{}_{\theta}-4\omega_{\alpha}{}^{\theta}{}_{\theta}\omega_{\iota}{}^{\theta}{}_{\theta}\partial_{\iota}f^{\alpha\iota}+4\omega_{\iota}{}^{\theta}{}_{\theta}\partial_{\iota}f^{\alpha\iota}-$$

$$2\partial_{\iota}f^{\theta}{}_{\theta}\partial_{\iota}f^{\alpha\iota}-2\partial_{\iota}f^{\alpha\iota}\partial_{\theta}f^{\theta}{}_{\theta}+4\partial_{\iota}f^{\alpha}{}_{\alpha}\partial_{\theta}f^{\theta}{}_{\theta}-2\partial_{\alpha}f_{\iota\theta}\partial^{\theta}f^{\alpha\iota}-\partial_{\alpha}f_{\theta\iota}\partial^{\theta}f^{\alpha\iota}+$$

$$\partial_{\iota}f_{\alpha\theta}\partial^{\theta}f^{\alpha\iota}+\partial_{\theta}f_{\alpha\iota}\partial^{\theta}f^{\alpha\iota}+\partial_{\theta}f_{\iota\alpha}\partial^{\theta}f^{\alpha\iota}+2\omega_{\alpha\theta\iota}(\omega^{\alpha\iota\theta}+2\partial^{\theta}f^{\alpha\iota}))+$$

$$\frac{1}{3}r_2(4\partial_{\beta}\omega_{\alpha\iota\theta}-2\partial_{\beta}\omega_{\alpha\theta\iota}+2\partial_{\beta}\omega_{\iota\theta\alpha}-\partial_{\iota}\omega_{\alpha\beta\theta}+\partial_{\theta}\omega_{\alpha\beta\iota}-2\partial_{\theta}\omega_{\alpha\iota\beta})$$

$$\partial^{\theta}\omega^{\alpha\beta\iota'})[t,x,y,z]dzdydxdt$$

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

$\omega_{0+}^{\#1} \dagger$	$f_{0+}^{\#1} \alpha\beta$	$f_{0+}^{\#2} \alpha\beta$	$\omega_{0-}^{\#1} \alpha\beta\chi$
$-t_1$	$i\sqrt{2}k t_1$	0	0
$-i\sqrt{2}k t_1$	$-2k^2 t_1$	0	0
0	0	0	0
0	0	0	$k^2 r_2 - t_1$

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

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

(No massless particles)
(see on)

Unitarity conditions

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