

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	$\frac{\sqrt{2}}{t_1+2k^2}t_1$	$\frac{2k^2r_1+t_1}{(t_1+2k^2}t_1)^2}$	0	$\frac{i\sqrt{2}k(2k^2r_1+t_1)}{(t_1+2k^2}t_1)^2}$
0	0	0	0	0	0	0
0	0	0	$-\frac{2ik}{t_1+2k^2}t_1$	$-\frac{i\sqrt{2}k(2k^2r_1+t_1)}{(t_1+2k^2}t_1)^2}$	0	$\frac{2k^2(2k^2r_1+t_1)}{(t_1+2k^2}t_1)^2}$

Quadratic (free) action

$$S=$$

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

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

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

$$\frac{2}{3}r_1(3\partial_{\beta}\omega_{\theta}^{\theta}\partial_{\theta}^{\prime}\omega_{\alpha}^{\alpha\beta}-3\partial_{\theta}\omega_{\beta}^{\theta}\partial_{\theta}^{\prime}\omega_{\alpha}^{\alpha\beta}-3\partial_{\alpha}\omega^{\alpha\beta i}\partial_{\theta}\omega_{\beta}^{\theta}+$$

$$6\partial_{\theta}^{\prime}\omega_{\alpha}^{\alpha\beta}\partial_{\theta}\omega_{\beta}^{\theta}+3\partial_{\alpha}\omega^{\alpha\beta i}\partial_{\theta}\omega_{\theta}^{\theta}-6\partial_{\theta}^{\prime}\omega_{\alpha}^{\alpha\beta}\partial_{\theta}\omega_{\theta}^{\theta}+$$

$$2\partial_{\beta}\omega_{\alpha i\theta}\partial^{\theta}\omega^{\alpha\beta i}-\partial_{\beta}\omega_{\alpha\theta i}^{\theta}\partial^{\theta}\omega^{\alpha\beta i}+4\partial_{\beta}\omega_{\theta\alpha}\partial^{\theta}\omega^{\alpha\beta i}+\partial_{\theta}\omega_{\alpha\beta\theta}\partial^{\theta}\omega^{\alpha\beta i}]-$$

$$\partial_{\theta}\omega_{\alpha\beta i}\partial^{\theta}\omega^{\alpha\beta i}-\partial_{\theta}\omega_{\alpha i\beta}\partial^{\theta}\omega^{\alpha\beta i})][t,x,y,z]dzdydxdt$$

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

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