

Particle spectrograph

Wave operator and propagator

Quadratic (free) action

$$S_F ==$$
$$\int\int\int\int(\frac{1}{6}(-2(t_1-2t_3)\omega_{\kappa\alpha}^{\alpha'}\omega_{\kappa\alpha}^{\kappa}-6t_1\omega_{\kappa\lambda}^{\kappa\lambda}\omega_{\kappa\lambda}^{\lambda'}+6f^{\alpha\beta}\tau_{\alpha\beta}+\omega^{\alpha\beta\chi}\sigma_{\alpha\beta\chi}+$$
$$4r_2\partial^\beta\omega_{\kappa}^{\theta\alpha}\partial_\theta\omega_{\alpha\beta}^{\kappa}-2r_2\partial_\theta\omega_{\alpha\beta}^{\kappa}\partial_\kappa\omega^{\alpha\beta\theta}-4r_2\partial_\theta\omega_{\alpha\beta}^{\kappa}\partial_\kappa\omega^{\theta\alpha\beta}-$$
$$3t_1\partial^\alpha f_{\theta\kappa}\partial^\kappa f_{\alpha}^{\theta}-3t_1\partial^\alpha f_{\kappa\theta}\partial^\theta f_{\alpha}^{\kappa}-3t_1\partial^\alpha f_{\lambda}^{\theta}\partial^\theta f_{\alpha}^{\lambda}+2t_1\omega_{\kappa\alpha}^{\alpha}\partial^\kappa f_{\lambda}^{\theta}-$$
$$4t_3\omega_{\kappa\alpha}^{\alpha}\partial^\kappa f_{\lambda}^{\theta}+2t_1\omega_{\kappa\lambda}^{\lambda}\partial^\kappa f_{\lambda}^{\theta}-4t_3\omega_{\kappa\lambda}^{\lambda}\partial^\kappa f_{\lambda}^{\theta}+4t_1\partial^\alpha f_{\kappa\alpha}\partial^\kappa f_{\lambda}^{\theta}-$$
$$8t_3\partial^\alpha f_{\kappa\alpha}\partial^\kappa f_{\lambda}^{\theta}-2t_1\partial_\kappa f_{\lambda}^{\lambda}\partial^\kappa f_{\lambda}^{\theta}+4t_3\partial_\kappa f_{\lambda}^{\lambda}\partial^\kappa f_{\lambda}^{\theta}+12t_1\omega_{\kappa\theta}\partial^\kappa f_{\lambda}^{\theta}-$$
$$2t_1\omega_{\lambda\alpha}^{\alpha}\partial^\kappa f_{\kappa}^{\lambda}+4t_3\omega_{\kappa\alpha}^{\alpha}\partial^\kappa f_{\kappa}^{\lambda}-2t_1\omega_{\lambda\alpha}^{\lambda}\partial^\kappa f_{\kappa}^{\lambda}+4t_3\omega_{\lambda\alpha}^{\lambda}\partial^\kappa f_{\kappa}^{\lambda}+$$
$$3t_1\partial^\alpha f_{\kappa}^{\lambda}\partial^\kappa f_{\lambda\alpha}+3t_1\partial_\kappa f_{\lambda}^{\lambda}\partial^\kappa f_{\lambda}^{\theta}+3t_1\partial_\kappa f_{\lambda}^{\theta}\partial^\kappa f_{\lambda}^{\theta}-2t_1\partial^\alpha f_{\lambda}^{\alpha}\partial^\kappa f_{\lambda\kappa}+$$
$$4t_3\partial^\alpha f_{\alpha}^{\lambda}\partial^\kappa f_{\lambda\kappa}+2r_2\partial_\kappa\omega^{\alpha\beta\theta}\partial^\kappa\omega_{\alpha\beta\theta}+4r_2\partial_\kappa\omega^{\theta\alpha\beta}\partial^\kappa\omega_{\alpha\beta\theta}-$$
$$4r_2\partial^\beta\omega_{\lambda}^{\alpha\lambda}\partial_\lambda\omega_{\alpha\beta}^{\lambda'}+4r_2\partial^\beta\omega_{\lambda}^{\lambda\alpha}\partial_\lambda\omega_{\alpha\beta}^{\lambda'})[t,x,y,z]dzdydxdt$$

$\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1+}^{\#2}$	$\tau_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1-}^{\#1}$	$\sigma_{1-}^{\#2}$	$\tau_{1-}^{\#1}$	$\tau_{1-}^{\#2}$
0	$-\frac{\sqrt{2}}{t_1+\kappa^2t_1}$	$-\frac{i\sqrt{2}k}{t_1+\kappa^2t_1}$	0	0	0	0
$-\frac{\sqrt{2}}{t_1+\kappa^2t_1}$	$\frac{1}{(1+\kappa^2)^2t_1}$	$\frac{ik}{(1+\kappa^2)^2t_1}$	0	0	0	0
$\frac{i\sqrt{2}k}{t_1+\kappa^2t_1}$	$-\frac{ik}{(1+\kappa^2)^2t_1}$	$\frac{k^2}{(1+\kappa^2)^2t_1}$	0	0	0	0
0	0	0	$\frac{2(t_1+t_3)}{3t_1t_3}$	$-\frac{\sqrt{2}(t_1-2t_3)}{3(1+2\kappa^2)t_1t_3}$	0	$-\frac{2ikt_1-4ikt_3}{3t_1t_3+6\kappa^2t_1t_3}$
0	0	0	0	$-\frac{\sqrt{2}(t_1-2t_3)}{3(1+2\kappa^2)t_1t_3}$	0	$\frac{i\sqrt{2}k(t_1+4t_3)}{3(1+2\kappa^2)^2t_1t_3}$
0	0	0	0	0	0	0
0	0	0	$\frac{2ikt_1-4ikt_3}{3t_1t_3+6\kappa^2t_1t_3}$	$-\frac{i\sqrt{2}k(t_1+4t_3)}{3(1+2\kappa^2)^2t_1t_3}$	0	$\frac{2\kappa^2(t_1+4t_3)}{3(1+2\kappa^2)^2t_1t_3}$

$\omega_{1+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1+}^{\#2}$	$f_{1+}^{\#1}$	$\omega_{1-}^{\#1}$	$\omega_{1-}^{\#2}$	$f_{1-}^{\#1}$	$f_{1-}^{\#2}$
$-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	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	$\frac{1}{6}(t_1+4t_3)$	$\frac{t_1-2t_3}{3\sqrt{2}}$	0	$\frac{1}{3}ik(t_1-2t_3)$
0	0	0	$\frac{t_1-2t_3}{3\sqrt{2}}$	$\frac{t_1+t_3}{3}$	0	$\frac{1}{3}i\sqrt{2}k(t_1+t_3)$
0	0	0	0	0	0	0
0	0	0	$-\frac{1}{3}ik(t_1-2t_3)$	$-\frac{1}{3}i\sqrt{2}k(t_1+t_3)$	0	$\frac{2}{3}\kappa^2(t_1+t_3)$

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

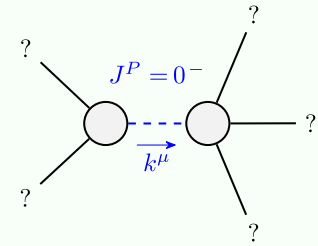
$\omega_{0+}^{\#1}$	$f_{0+}^{\#1}$	$f_{0+}^{\#2}$	$\omega_0^{\#1}$
t_3	$-i\sqrt{2}kt_3$	0	0
$i\sqrt{2}kt_3$	$2\kappa^2t_3$	0	0
0	0	0	0
0	0	0	$\kappa^2r_2-t_1$

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

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

$\sigma_{0+}^{\#1} \dagger$	$\tau_{0+}^{\#1}$	$\tau_{0+}^{\#2}$	$\sigma_{0-}^{\#1}$
$\frac{1}{(1+2\kappa^2)^2t_3}$	$-\frac{i\sqrt{2}k}{(1+2\kappa^2)^2t_3}$	0	0
$\frac{i\sqrt{2}k}{(1+2\kappa^2)^2t_3}$	$\frac{2\kappa^2}{(1+2\kappa^2)^2t_3}$	0	0
0	0	0	0
0	0	0	$\frac{1}{\kappa^2r_2-t_1}$

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

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