

Particle spectrograph

Wave operator and propagator

$\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1+}^{\#2} \alpha\beta$	$\tau_{1+}^{\#1} \alpha\beta$	$\sigma_{1-}^{\#1} \alpha$	$\sigma_{1-}^{\#2} \alpha$	$\tau_{1-}^{\#1} \alpha$	$\tau_{1-}^{\#2} \alpha$
$\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1+k^2}t_1$	$-\frac{i\sqrt{2}k}{t_1+k^2}t_1$	0	0	0
$\sigma_{1+}^{\#2} \dagger^{\alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2}t_1$	$\frac{-2k^2(2r_3+r_5)+t_1}{(1+k^2)^2}t_1$	$\frac{-2ik^3(2r_3+r_5)+ik t_1}{(1+k^2)^2}t_1^2$	0	0	0
$\tau_{1+}^{\#1} \dagger^{\alpha\beta}$	$\frac{i\sqrt{2}k}{t_1+k^2}t_1$	$\frac{i(2k^3(2r_3+r_5)-kt_1)}{(1+k^2)^2}t_1^2$	$\frac{-2k^4(2r_3+r_5)+k^2t_1}{(1+k^2)^2}t_1^2$	0	0	0
$\sigma_{1-}^{\#1} \dagger^{\alpha}$	0	0	0	$\frac{1}{k^2(-r_1+2r_3+r_5)}$	0	$\frac{i}{k(1+2k^2)(r_1-2r_3-r_5)}$
$\sigma_{1-}^{\#2} \dagger^{\alpha}$	0	0	0	$\frac{1}{\sqrt{2}(k^2+2k^4)(r_1-2r_3-r_5)}$	0	$\frac{1}{\sqrt{2}k(1+2k^2)^2(r_1-2r_3-r_5)}t_1$
$\tau_{1-}^{\#1} \dagger^{\alpha}$	0	0	0	0	0	0
$\tau_{1-}^{\#2} \dagger^{\alpha}$	0	0	0	$\frac{i}{k(1+2k^2)(-r_1+2r_3+r_5)}$	0	$\frac{1}{-r_1+2r_3+r_5}+\frac{6k^2}{(1+2k^2)^2}t_1$

Quadratic (free) action

$$S=$$
$$\iiint(f^{\alpha\beta} \tau_{\alpha\beta} + \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + \frac{1}{6}t_1(2\omega^{\alpha i} \omega_{\alpha}{}^{\theta}{}_{,\theta} - 4\omega_{\alpha}{}^{\theta}{}_{,\theta} \partial_{\theta} f^{\alpha i} + 4\omega_{\theta}{}^{\theta}{}_{,\theta} \partial_{\theta} f^{\alpha}{}_{\alpha} - 2\partial_{\theta} f^{\theta}{}_{\alpha} \partial_{\theta} f^{\alpha}{}_{\alpha} - 2\partial_{\theta} f^{\alpha i} \partial_{\theta} f^{\theta}{}_{\alpha} + 4\partial_{\theta} f^{\alpha}{}_{\alpha} \partial_{\theta} f^{\theta}{}_{\theta} - 6\partial_{\alpha} f_{,\theta} \partial^{\theta} f^{\alpha i} - 3\partial_{\alpha} f_{,\theta} \partial^{\theta} f^{\alpha i} + 3\partial_{\theta} f_{,\alpha\theta} \partial^{\theta} f^{\alpha i} + 3\partial_{\theta} f_{,\alpha} \partial^{\theta} f^{\alpha i} + 3\partial_{\theta} f_{,\alpha} \partial^{\theta} f^{\alpha i}) - 2r_3(\partial_{\beta} \omega_{\theta}{}^{\theta} \partial_{\theta} \omega_{\theta}{}^{\alpha\beta} + \partial_{\theta} \omega_{\beta}{}^{\theta} \partial_{\theta} \omega_{\theta}{}^{\alpha\beta} + \partial_{\alpha} \omega^{\alpha\beta i} \partial_{\theta} \omega_{\beta}{}^{\theta} - 2\partial_{\theta} \omega_{\beta}{}^{\theta} \partial_{\theta} \omega_{\theta}{}^{\alpha\beta} + \partial_{\alpha} \omega^{\alpha\beta i} \partial_{\theta} \omega_{\theta}{}^{\alpha\beta} + 2\partial_{\beta} \omega_{,\theta\alpha} \partial^{\theta} \omega^{\alpha\beta i}) + \frac{2}{3}r_1(3\partial_{\beta} \omega_{\theta}{}^{\theta} \partial_{\theta} \omega_{\theta}{}^{\alpha\beta} + 3\partial_{\theta} \omega_{\beta}{}^{\theta} \partial_{\theta} \omega_{\theta}{}^{\alpha\beta} + 3\partial_{\alpha} \omega^{\alpha\beta i} \partial_{\theta} \omega_{\theta}{}^{\alpha\beta} - 6\partial_{\theta} \omega_{\theta}{}^{\alpha\beta} \partial_{\theta} \omega_{\theta}{}^{\alpha\beta} + 3\partial_{\alpha} \omega^{\alpha\beta i} \partial_{\theta} \omega_{\theta}{}^{\alpha\beta} - 6\partial_{\theta} \omega_{\theta}{}^{\alpha\beta} \partial_{\theta} \omega_{\theta}{}^{\alpha\beta} + \partial_{\theta} \omega_{\alpha\beta} \partial^{\theta} \omega^{\alpha\beta i} + \partial_{\theta} \omega_{\alpha\beta} \partial^{\theta} \omega^{\alpha\beta i}) + r_5(\partial_{\theta} \omega_{\theta}{}^{\kappa} \partial_{\theta} \omega_{\kappa}{}^{\alpha i} - \partial_{\theta} \omega_{\theta}{}^{\kappa} \partial_{\theta} \omega_{\kappa}{}^{\alpha i} - (\partial_{\alpha} \omega^{\alpha i\theta} - 2\partial^{\theta} \omega^{\alpha i}) (\partial_{\kappa} \omega_{\theta}{}^{\kappa} - \partial_{\kappa} \omega_{\theta}{}^{\kappa})) [t, x, y, z] dz dy dx dt$$

	$\omega_{1+}^{\#1} \alpha\beta$	$\omega_{1+}^{\#2} \alpha\beta$	$f_{1+}^{\#1} \alpha\beta$	$\omega_{1-}^{\#1} \alpha$	$\omega_{1-}^{\#2} \alpha$	$f_{1-}^{\#1} \alpha$	$f_{1-}^{\#2} \alpha$
$\omega_{1+}^{\#1} \dagger^{\alpha\beta}$	$k^2(2r_3+r_5) - \frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$\omega_{1+}^{\#2} \dagger^{\alpha\beta}$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$f_{1+}^{\#1} \dagger^{\alpha\beta}$	$\frac{ikt_1}{\sqrt{2}}$	0	0	0	0	0	0
$\omega_{1-}^{\#1} \dagger^{\alpha}$	0	0	0	$k^2(-r_1+2r_3+r_5) + \frac{t_1}{6}$	$\frac{t_1}{3\sqrt{2}}$	0	$\frac{ikt_1}{3}$
$\omega_{1-}^{\#2} \dagger^{\alpha}$	0	0	0	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	0	$\frac{1}{3}i\sqrt{2}kt_1$
$f_{1-}^{\#1} \dagger^{\alpha}$	0	0	0	0	0	0	0
$f_{1-}^{\#2} \dagger^{\alpha}$	0	0	0	$-\frac{1}{3}ikt_1$	$-\frac{1}{3}i\sqrt{2}kt_1$	0	$\frac{2k^2t_1}{3}$

$\sigma_0^{\#1} \dagger$	$\tau_0^{\#1} \dagger$	$\tau_0^{\#2} \dagger$	$\sigma_0^{\#1} \dagger$
$\frac{1}{6k^2(-r_1+r_3)}$	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$-\frac{1}{t_1}$

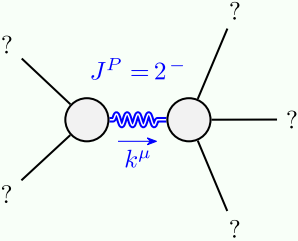
$\sigma_{2+}^{\#1} \dagger^{\alpha\beta}$	$\tau_{2+}^{\#1} \alpha\beta$	$\sigma_{2-}^{\#1} \alpha\beta\chi$
$\sigma_{2+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{2i\sqrt{2}k}{(1+2k^2)^2}t_1$	0
$\tau_{2+}^{\#1} \dagger^{\alpha\beta}$	$\frac{4k^2}{(1+2k^2)^2}t_1$	0
$\sigma_{2-}^{\#1} \dagger^{\alpha\beta\chi}$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

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

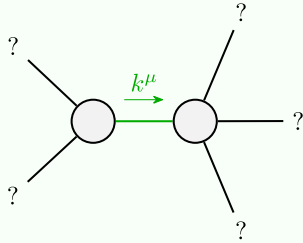
$\omega_0^{\#1} \dagger$	$f_0^{\#1} \dagger$	$\omega_0^{\#2} \dagger$	$f_0^{\#2} \dagger$	$\omega_0^{\#1} \dagger$
$\omega_0^{\#1} \dagger$	$6k^2(-r_1+r_3)$	0	0	0
$f_0^{\#1} \dagger$	0	0	0	0
$f_0^{\#2} \dagger$	0	0	0	0
$\omega_0^{\#1} \dagger$	0	0	0	$-t_1$

Source constraints/gauge generators	
SO(3) irreps	Multiplicities
$\tau_{0+}^{\#2} == 0$	1
$\tau_{0+}^{\#1} == 0$	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



Quadratic pole	
Pole residue:	$\frac{1}{(r_1-2r_3-r_5)t_1^2} > 0$
Polarisations:	2

Unitarity conditions

$r_1 < 0 \ \&\& \ r_5 < r_1 - 2r_3 \ \&\& \ t_1 > 0$