

Particle spectrograph

Wave operator and propagator

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

Quadratic (free) Lagrangian density

$$\begin{aligned}
 &-t_1 \omega_{\lambda'}^{\alpha\iota} \omega_{\kappa\alpha}^{\kappa}-\frac{1}{3}t_1 \omega_{\kappa\lambda}^{\kappa\lambda} \omega_{\lambda'}^{\iota}+\frac{1}{3}t_1 \omega_{\kappa\lambda}^{\iota} \omega_{\lambda'}^{\kappa\lambda}+f^{\alpha\beta} \tau_{\alpha\beta}+ \\
 &\omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi}^{-}r_5\partial_{\iota}\omega_{\kappa}^{\kappa\lambda} \partial^{\iota}\omega_{\lambda}^{\alpha}-\frac{2}{3}r_1\partial^{\beta}\omega_{\alpha}^{\theta\alpha} \partial_{\theta}\omega_{\alpha\beta}^{\kappa}-\frac{2}{3}r_1\partial_{\theta}\omega_{\alpha\beta}^{\kappa} \partial_{\kappa}\omega^{\alpha\beta\theta}+ \\
 &\frac{2}{3}r_1\partial_{\theta}\omega_{\alpha\beta}^{\kappa} \partial_{\kappa}\omega^{\theta\alpha\beta}-r_5\partial_{\alpha}\omega_{\lambda}^{\alpha} \partial_{\theta}\omega_{\kappa\lambda}^{\theta\kappa\lambda}+r_5\partial_{\theta}\omega_{\lambda}^{\alpha} \partial_{\kappa}\omega^{\theta\kappa\lambda}-r_5\partial_{\alpha}\omega_{\lambda}^{\alpha} \partial_{\theta}\omega^{\kappa\lambda\theta}+ \\
 &2r_5\partial_{\theta}\omega_{\lambda}^{\alpha} \partial_{\kappa}\omega_{\alpha}^{\kappa\lambda\theta}-\frac{1}{3}t_1\partial^{\alpha}f_{\theta\kappa}^{\kappa} \partial^{\kappa}f_{\alpha}^{\theta}-\frac{2}{3}t_1\partial^{\alpha}f_{\kappa\theta}^{\theta} \partial^{\kappa}f_{\alpha}^{\theta}-\frac{1}{3}t_1\partial^{\alpha}f_{\alpha}^{\kappa} \partial^{\kappa}f_{\lambda}^{\lambda}+ \\
 &t_1 \omega_{\kappa\alpha}^{\alpha} \partial^{\kappa}f_{\lambda'}^{\iota}+t_1 \omega_{\kappa\lambda}^{\lambda} \partial^{\kappa}f_{\iota'}^{\iota}+2t_1\partial^{\alpha}f_{\kappa\alpha}^{\kappa} \partial^{\kappa}f_{\iota'}^{\iota}-t_1\partial_{\kappa}f_{\lambda}^{\lambda} \partial^{\kappa}f_{\iota'}^{\iota}+ \\
 &\frac{1}{3}t_1 \omega_{\iota\theta\kappa} \partial^{\kappa}f_{\theta}^{\iota\theta}+\frac{4}{3}t_1 \omega_{\iota\kappa\theta} \partial^{\kappa}f_{\theta}^{\iota\theta}-\frac{1}{3}t_1 \omega_{\theta\iota\kappa} \partial^{\kappa}f_{\theta}^{\iota\theta}-\frac{1}{3}t_1 \omega_{\theta\iota\kappa} \partial^{\kappa}f_{\theta}^{\iota\theta}+\frac{2}{3}t_1 \omega_{\theta\kappa\iota} \partial^{\kappa}f_{\theta}^{\iota\theta}- \\
 &t_1 \omega_{\iota\alpha}^{\alpha} \partial^{\kappa}f_{\kappa}^{\iota}-t_1 \omega_{\iota\lambda}^{\lambda} \partial^{\kappa}f_{\lambda}^{\iota}+\frac{1}{3}t_1\partial^{\alpha}f_{\lambda}^{\alpha} \partial^{\kappa}f_{\lambda\alpha}^{\lambda}+\frac{1}{3}t_1\partial_{\kappa}f_{\lambda}^{\lambda} \partial^{\kappa}f_{\lambda}^{\theta}+ \\
 &\frac{2}{3}t_1\partial_{\kappa}f_{\theta}^{\lambda} \partial^{\kappa}f_{\lambda}^{\theta}-t_1\partial^{\alpha}f_{\lambda}^{\alpha} \partial^{\kappa}f_{\lambda\kappa}^{\lambda}+\frac{2}{3}r_1\partial_{\kappa}\omega^{\alpha\beta\theta} \partial^{\kappa}\omega_{\alpha\beta\theta}^{-}-\frac{2}{3}r_1\partial_{\kappa}\omega^{\theta\alpha\beta} \partial^{\kappa}\omega_{\alpha\beta\theta}^{\kappa}+ \\
 &\frac{2}{3}r_1\partial^{\beta}\omega_{\iota}^{\alpha\lambda} \partial_{\lambda}\omega_{\alpha\beta}^{\iota}-\frac{8}{3}r_1\partial^{\beta}\omega_{\iota'}^{\lambda\alpha} \partial_{\lambda}\omega_{\alpha\beta}^{\iota'}+r_5\partial_{\alpha}\omega_{\lambda}^{\alpha} \partial^{\lambda}\omega_{\theta}^{\theta\kappa}-r_5\partial_{\theta}\omega_{\lambda}^{\alpha} \partial^{\lambda}\omega_{\alpha}^{\theta\kappa} \omega_{\kappa}
 \end{aligned}$$

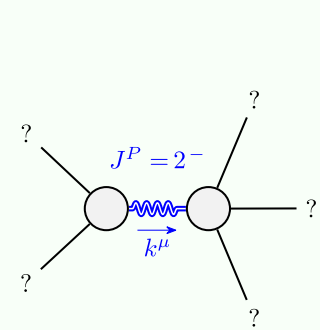
$$\begin{array}{c}
 \omega_{2+}^{\#1} \dagger^{\alpha\beta} \quad f_{2+}^{\#1} \dagger^{\alpha\beta} \quad \omega_{2+}^{\#1} \alpha\beta\chi \\
 \begin{array}{|c|c|c|}
 \hline
 \omega_{2+}^{\#1} \dagger^{\alpha\beta} & \frac{t_1}{2} & -\frac{ikt_1}{\sqrt{2}} \\
 \hline
 f_{2+}^{\#1} \dagger^{\alpha\beta} & \frac{ikt_1}{\sqrt{2}} & k^2t_1 \\
 \hline
 \omega_{2+}^{\#1} \dagger^{\alpha\beta\chi} & 0 & k^2r_1+\frac{t_1}{2} \\
 \hline
 \end{array}
 \end{array}$$

$$\begin{array}{c}
 \omega_{0+}^{\#1} \quad f_{0+}^{\#1} \quad f_{0+}^{\#2} \quad \omega_{0+}^{\#1} \\
 \begin{array}{|c|c|c|c|}
 \hline
 \omega_{0+}^{\#1} & -t_1 & i\sqrt{2}kt_1 & 0 \\
 \hline
 f_{0+}^{\#1} & -i\sqrt{2}kt_1 & -2k^2t_1 & 0 \\
 \hline
 f_{0+}^{\#2} & 0 & 0 & 0 \\
 \hline
 \omega_{0+}^{\#1} & 0 & 0 & 0 \\
 \hline
 \end{array}
 \end{array}$$

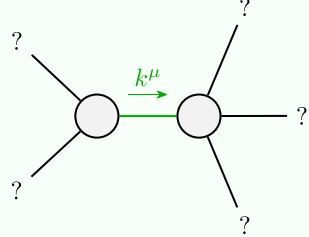
Source constraints/gauge generators	
SO(3) irreps	Multiplicities
$\sigma_0^{\#1} == 0$	1
$\tau_0^{\#2} == 0$	1
$\tau_0^{\#1} - 2ik\sigma_0^{\#1} == 0$	1
$\tau_1^{\#2\alpha} + 2ik\sigma_1^{\#2\alpha} == 0$	3
$\tau_1^{\#1\alpha} == 0$	3
$\tau_1^{\#1\alpha\beta} + ik\sigma_1^{\#2\alpha\beta} == 0$	3
$\tau_2^{\#1\alpha\beta} - 2ik\sigma_2^{\#1\alpha\beta} == 0$	5
Total constraints:	17

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

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:	$\frac{1}{(2r_1+r_5)t_1^2p^2} > 0$
Polarisations:	2

Unitarity conditions

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