

Particle spectrograph

Wave operator and propagator

Quadratic (free) Lagrangian density

$$\begin{aligned} &\frac{2}{3}t_2\omega_{\lambda'}^{\kappa\lambda}\omega_{\kappa\lambda}'+\frac{1}{3}t_2\omega_{\kappa\lambda}'\omega_{\kappa\lambda}'+f^{\alpha\beta}{}_{\lambda}\tau_{\alpha\beta}+\omega^{\alpha\beta\chi}{}_{\sigma}\sigma_{\alpha\beta\chi}-r_3\partial_{\lambda'}\omega_{\kappa}^{\kappa\lambda}\partial^{\kappa}\omega_{\lambda}^{\alpha}{}_{\alpha}+ \\ &\frac{2}{3}r_2\partial^{\beta}\omega_{\kappa}^{\theta\alpha}\partial_{\theta}\omega_{\alpha\beta}{}^{\kappa}-\frac{1}{3}r_2\partial_{\theta}\omega_{\alpha\beta}{}^{\kappa}\partial_{\kappa}\omega^{\alpha\beta\theta}-\frac{2}{3}r_2\partial_{\theta}\omega_{\alpha\beta}{}^{\kappa}\partial_{\kappa}\omega^{\theta\alpha\beta}+ \\ &3r_3\partial_{\alpha}\omega_{\lambda}^{\alpha}\partial_{\kappa}\omega_{\lambda}^{\theta\kappa\lambda}-3r_3\partial_{\theta}\omega_{\lambda}^{\alpha}\partial_{\kappa}\omega_{\alpha}^{\theta\kappa\lambda}-r_3\partial_{\alpha}\omega_{\lambda}^{\alpha}\partial_{\kappa}\omega^{\kappa\lambda\theta}+ \\ &2r_3\partial_{\theta}\omega_{\lambda}^{\alpha}\partial_{\kappa}\omega_{\alpha}^{\kappa\lambda\theta}+\frac{1}{6}t_2\partial^{\alpha}f_{\theta\kappa}\partial^{\kappa}f_{\alpha}{}^{\theta}-\frac{1}{6}t_2\partial_2^{\alpha}f_{\kappa\theta}\partial^{\kappa}f_{\alpha}{}^{\theta}+\frac{1}{6}t_2\partial^{\alpha}f_{\lambda}{}^{\kappa}\partial^{\kappa}f_{\alpha\lambda}+ \\ &\frac{1}{3}t_2\omega_{\theta\kappa}\partial^{\kappa}f'^{\theta}-\frac{2}{3}t_2\omega_{\kappa\theta}\partial^{\kappa}f'^{\theta}-\frac{1}{3}t_2\omega_{\theta\kappa}\partial^{\kappa}f'^{\theta}+\frac{2}{3}t_2\omega_{\theta\kappa}\partial^{\kappa}f'^{\theta}- \\ &\frac{1}{6}t_2\partial^{\alpha}f_{\lambda}{}^{\kappa}\partial^{\kappa}f_{\lambda\alpha}-\frac{1}{6}t_2\partial_2\kappa f_{\theta}^{\lambda}\partial^{\kappa}f_{\lambda}{}^{\theta}+\frac{1}{6}t_2\partial_{\kappa}f_{\lambda}^{\lambda}\partial^{\kappa}f_{\theta}^{\theta}+\frac{1}{3}r_2\partial_{\kappa}\omega^{\alpha\beta\theta}\partial^{\kappa}\omega_{\alpha\beta\theta}+ \\ &\frac{2}{3}r_2\partial_{\kappa}\omega^{\theta\alpha\beta}\partial^{\kappa}\omega_{\alpha\beta\theta}-\frac{2}{3}r_2\partial_{\theta}\omega_{\lambda}^{\alpha\lambda}\partial_{\lambda}\omega_{\alpha\beta}{}^{\lambda}+\frac{2}{3}r_2\partial^{\beta}\omega_{\lambda}^{\lambda\alpha}\partial_{\lambda}\omega_{\alpha\beta}{}^{\lambda}- \\ &4r_3\partial^{\beta}\omega_{\lambda}^{\lambda\alpha}\partial_{\lambda}\omega_{\alpha\beta}{}^{\lambda}-3r_3\partial_{\alpha}\omega_{\lambda}^{\alpha}\partial^{\lambda}\omega_{\theta\kappa}{}^{\alpha}+3r_3\partial_{\theta}\omega_{\lambda}^{\alpha}\partial^{\lambda}\omega_{\alpha\beta}{}^{\theta\kappa} \end{aligned}$$

	$\sigma_{1+}^{\#1} \dagger \alpha\beta$	$\sigma_{1+}^{\#2} \dagger \alpha\beta$	$\tau_{1+}^{\#1} \dagger \alpha\beta$	$\sigma_{1-}^{\#1} \dagger \alpha$	$\sigma_{1-}^{\#2} \dagger \alpha$	$\tau_{1-}^{\#1} \dagger \alpha$	$\tau_{1-}^{\#2} \dagger \alpha$
$\sigma_{1+}^{\#1} \dagger \alpha\beta$	$\frac{1}{k^2 r_3}$	$-\frac{\sqrt{2}}{k^2 r_3+k^4 r_3}$	$-\frac{i\sqrt{2}}{kr_3+k^3 r_3}$	0	0	0	0
$\sigma_{1+}^{\#2} \dagger \alpha\beta$	$-\frac{\sqrt{2}}{k^2 r_3+k^4 r_3}$	$\frac{3k^2 r_3+2t_2}{(k+k^3)^2 r_3 t_2}$	$\frac{i(3k^2 r_3+2t_2)}{k(1+k^2)^2 r_3 t_2}$	0	0	0	0
$\tau_{1+}^{\#1} \dagger \alpha\beta$	$-\frac{i\sqrt{2}}{kr_3+k^3 r_3}$	$-\frac{i(3k^2 r_3+2t_2)}{k(1+k^2)^2 r_3 t_2}$	$\frac{3k^2 r_3+2t_2}{(1+k^2)^2 r_3 t_2}$	0	0	0	0
$\sigma_{1-}^{\#1} \dagger \alpha$	0	0	0	$\frac{1}{k^2 r_3}$	0	0	0
$\sigma_{1-}^{\#2} \dagger \alpha$	0	0	0	0	0	0	0
$\tau_{1-}^{\#1} \dagger \alpha$	0	0	0	0	0	0	0
$\tau_{1-}^{\#2} \dagger \alpha$	0	0	0	0	0	0	0

	$\omega_{1+}^{\#1} \dagger \alpha\beta$	$\omega_{1+}^{\#2} \dagger \alpha\beta$	$f_{1+}^{\#1} \dagger \alpha\beta$	$\omega_{1-}^{\#1} \dagger \alpha$	$\omega_{1-}^{\#2} \dagger \alpha$	$f_{1-}^{\#1} \dagger \alpha$	$f_{1-}^{\#2} \dagger \alpha$
$\omega_{1+}^{\#1} \dagger \alpha\beta$	$k^2 r_3+\frac{2t_2}{3}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{1}{3}i\sqrt{2}kt_2$	0	0	0	0
$\omega_{1+}^{\#2} \dagger \alpha\beta$	$\frac{\sqrt{2}t_2}{3}$	$\frac{t_2}{3}$	$\frac{ikt_2}{3}$	0	0	0	0
$f_{1+}^{\#1} \dagger \alpha\beta$	$-\frac{1}{3}i\sqrt{2}kt_2$	$-\frac{1}{3}i\sqrt{2}kt_2$	$\frac{k^2t_2}{3}$	0	0	0	0
$\omega_{1-}^{\#1} \dagger \alpha$	0	0	0	$k^2 r_3$	0	0	0
$\omega_{1-}^{\#2} \dagger \alpha$	0	0	0	0	0	0	0
$f_{1-}^{\#1} \dagger \alpha$	0	0	0	0	0	0	0
$f_{1-}^{\#2} \dagger \alpha$	0	0	0	0	0	0	0

	$\sigma_{0+}^{\#1}$	$\tau_{0+}^{\#1}$	$\tau_{0+}^{\#2}$	$\sigma_{0-}^{\#1}$
$\sigma_{0+}^{\#1} \dagger$	$\frac{1}{6k^2 r_3}$	0	0	0
$\tau_{0+}^{\#1} \dagger$	0	0	0	0
$\tau_{0+}^{\#2} \dagger$	0	0	0	0
$\sigma_{0-}^{\#1} \dagger$	0	0	0	$\frac{1}{k^2 r_2+t_2}$

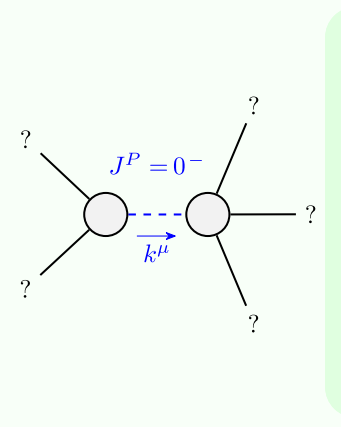
	$\omega_{0+}^{\#1}$	$f_{0+}^{\#1}$	$f_{0+}^{\#2}$	$\omega_{0-}^{\#1}$
$\omega_{0+}^{\#1} \dagger$	$6k^2 r_3$	0	0	0
$f_{0+}^{\#1} \dagger$	0	0	0	0
$f_{0+}^{\#2} \dagger$	0	0	0	0
$\omega_{0-}^{\#1} \dagger$	0	0	0	$k^2 r_2+t_2$

Source constraints/gauge generators	
SO(3) irreps	Multiplicities
$\tau_{0+}^{\#2} == 0$	1
$\tau_{0+}^{\#1} == 0$	1
$\tau_{1-}^{\#2\alpha} == 0$	3
$\tau_{1-}^{\#1\alpha} == 0$	3
$\sigma_{1-}^{\#2\alpha} == 0$	3
$\tau_{1+}^{\#1\alpha\beta} + i k \sigma_{1+}^{\#2\alpha\beta} == 0$	3
$\sigma_{2-}^{\#1\alpha\beta\chi} == 0$	5
$\tau_{2+}^{\#1\alpha\beta} == 0$	5
$\sigma_{2+}^{\#1\alpha\beta} == 0$	5
Total constraints:	29

	$\sigma_{2+}^{\#1} \dagger \alpha\beta$	$\tau_{2+}^{\#1} \dagger \alpha\beta$	$\sigma_{2-}^{\#1} \dagger \alpha\beta\chi$
$\sigma_{2+}^{\#1} \dagger \alpha\beta$	0	0	0
$\tau_{2+}^{\#1} \dagger \alpha\beta$	0	0	0
$\sigma_{2-}^{\#1} \dagger \alpha\beta\chi$	0	0	0

	$\omega_{2+}^{\#1} \dagger \alpha\beta$	$f_{2+}^{\#1} \dagger \alpha\beta$	$\omega_{2-}^{\#1} \dagger \alpha\beta\chi$
$\omega_{2+}^{\#1} \dagger \alpha\beta$	0	0	0
$f_{2+}^{\#1} \dagger \alpha\beta$	0	0	0
$\omega_{2-}^{\#1} \dagger \alpha\beta\chi$	0	0	0

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{r_2} > 0$
Polarisations:	1
Square mass:	$-\frac{t_2}{r_2} > 0$
Spin:	0
Parity:	Odd

(No massless particles)

Unitarity conditions

$$r_2 < 0 \ \&\& \ t_2 > 0$$