Particle spectrograph

Wave operator and propagator

Quadratic (free) action
$S_{F} = = = = = = = = = = = = = = = = = = =$
$6 r_1 \partial_{i} \omega^{\kappa \lambda}_{ \kappa} \partial^{i} \omega_{\lambda \alpha}^{ \alpha} - 4 r_1 \partial^{\beta} \omega^{\beta \alpha}_{ \kappa} \partial_{\theta} \omega_{\alpha\beta}^{ \kappa} - 4 r_1 \partial_{\theta} \omega_{\alpha\beta}^{ \kappa} \partial_{\kappa} \omega^{\alpha\beta\theta} +$
$4r_1\partial_\theta\omega_{\alpha\beta}^{\kappa}\partial_\kappa\omega^{\theta\alpha\beta} + 6r_1\partial_\alpha\omega_{\lambda}^{\alpha}\partial_\kappa\omega^{\theta\kappa\lambda} - 6r_1\partial_\theta\omega_{\lambda}^{\alpha}\partial_\kappa\omega^{\theta\kappa\lambda} +$
$6r_1\partial_\alpha\omega_\lambda^{\ \alpha}_{\ \ \theta}\partial_\kappa\omega^{\kappa\lambda\theta} - 12r_1\partial_\theta\omega_\lambda^{\ \alpha}_{\ \ \alpha}\partial_\kappa\omega^{\kappa\lambda\theta} - 3t_1\partial^\alpha f_{\theta\kappa}\partial^\kappa f_{\alpha}^{\ \ \theta} - 3t_1\partial^\alpha f_{\kappa\theta}\partial^\kappa f_{\alpha}^{\ \ \theta} -$
$3t_1\partial^{\alpha}f^{\lambda}_{}\partial^{\kappa}f_{\lambda}+2t_1\;\omega_{\kappa\alpha}^{\alpha}\;\partial^{\kappa}f'_{}-4t_3\;\omega_{\kappa\alpha}^{\alpha}\;\partial^{\kappa}f'_{}+2t_1\;\omega_{\kappa\lambda}^{\lambda}\;\partial^{\kappa}f'_{}-$
$4t_3\;\omega_{\kappa\lambda}^{\lambda}\;\partial^{\kappa}f'_{}+4t_1\partial^{\alpha}f_{}\partial^{\kappa}f'_{}-8t_3\partial^{\alpha}f_{}\partial^{\kappa}f'_{}-2t_1\partial_{\kappa}f^{\lambda}_{\lambda}\partial^{\kappa}f'_{}+$
$4t_3 \partial_\kappa f^\lambda_{\lambda} \partial^\kappa f'_{\mu} + 12t_1 \omega_{\iota\kappa\theta} \partial^\kappa f'^\theta - 2t_1 \omega_{\iota\alpha}^{\alpha} \partial^\kappa f'_{\kappa} + 4t_3 \omega_{\iota\alpha}^{\alpha} \partial^\kappa f'_{\kappa} -$
$2t_1\;\omega_{_{1}\lambda}^{\lambda}\partial^{\kappa}f'_{\kappa}+4t_3\;\omega_{_{1}\lambda}^{\lambda}\partial^{\kappa}f'_{\kappa}+3t_1\partial^{\alpha}f^{\lambda}_{\kappa}\partial^{\kappa}f_{\lambda\alpha}+3t_1\partial_{\kappa}f_{\theta}^{\lambda}\partial^{\kappa}f_{\theta}^{\lambda}+$
$3t_1\partial_\kappa f^\lambda_{\theta}\partial^\kappa f_{\lambda}^{\theta}-2t_1\partial^\alpha f^\lambda_{\alpha}\partial^\kappa f_{\lambda\kappa}+4t_3\partial^\alpha f^\lambda_{\alpha}\partial^\kappa f_{\lambda\kappa}+4r_1\partial_\kappa \omega^{\alpha\beta\theta}\partial^\kappa \omega_{\alpha\beta\theta}-$
$4r_1\partial_\kappa\omega^{\theta\alpha\beta}\partial^\kappa\omega_{\alpha\beta\theta} + 4r_1\partial^\beta\omega_{,}{}^{\alpha\lambda}\partial_\lambda\omega_{\alpha\beta}^{} - 16r_1\partial^\beta\omega_{,}{}^{\lambda\alpha}\partial_\lambda\omega_{\alpha\beta}^{} -$
$6 r_1 \partial_\alpha \omega_\lambda^{\ \alpha}_{\ \ \theta} \partial^\lambda \omega^{\theta \kappa}_{\ \kappa} + 6 r_1 \partial_\theta \omega_\lambda^{\ \alpha}_{\ \alpha} \partial^\lambda \omega^{\theta \kappa}_{\ \kappa}) [t, \varkappa, y, z] dz dy dx dt$

_							
$\tau_{1}^{\#2}{}_{\alpha}$	0	0	0	$-\frac{2ikt_1-4ikt_3}{3t_1t_3+6k^2t_1t_3}$	$\frac{i\sqrt{2} k(t_1+4t_3)}{3(1+2k^2)^2 t_1 t_3}$	0	$\frac{2k^2(t_1+4t_3)}{3(1+2k^2)^2t_1t_3}$
$\tau_{1^{-}}^{\#1}\alpha$	0	0	0	0	0	0	0
$\sigma_{1^{-}lpha}^{\#2}$	0	0	0	$-\frac{\sqrt{2} (t_1 - 2t_3)}{3(1 + 2k^2)t_1t_3}$	$\frac{t_1+4t_3}{3(1+2k^2)^2t_1t_3}$	0	$-\frac{i\sqrt{2}k(t_1+4t_3)}{3(1+2k^2)^2t_1t_3}$
$\sigma_{1^{-}\alpha}^{\#1}$	0	0	0	$\frac{2(t_1+t_3)}{3t_1t_3}$	$-\frac{\sqrt{2} (t_1-2t_3)}{3(1+2k^2)t_1t_3}$	0	$\frac{2ik(t_1-2t_3)}{3t_1t_3+6k^2t_1t_3}$
$\tau_1^{\#1}_{+\alpha\beta}$	$-\frac{i\sqrt{2}k}{t_1+k^2t_1}$	$-\frac{i(2k^3r_1-kt_1)}{(1+k^2)^2t_1^2}$	$\frac{-2k^4r_1+k^2t_1}{(1+k^2)^2t_1^2}$	0	0	0	0
$\sigma_{1}^{\#2}{}_{\alpha\beta}$		$\frac{-2k^2r_1+t_1}{(1+k^2)^2t_1^2}$	$\frac{i(2k^3r_1-kt_1)}{(1+k^2)^2t_1^2}$	0	0	0	0
$\sigma_{1}^{\#1}{}_{+}\alpha\beta$	0	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	$\frac{i\sqrt{2}k}{t_1+k^2t_1}$	0	0	0	0
	$J_1^{#1} + \alpha \beta$	$\sigma_1^{\#2} + \alpha \beta$	$\tau_{1}^{#1} + \alpha \beta$	$\sigma_{1^{\bar{-}}}^{\#1} +^{\alpha}$	$\sigma_{1}^{\#2} +^{lpha}$	$\tau_{1}^{\#1} +^{\alpha}$	$\tau_1^{\#2} + \alpha$

$f_1^{#2}$	0	0	0	$\frac{1}{3}$ i k (t_1 - 2 t_3)	$\frac{1}{3}\bar{l}\sqrt{2}k(t_1+t_3)$	0	$\frac{2}{3} k^2 (t_1 + t_3)$
$f_{1^-}^{\#1} \alpha$	0	0	0	0	0	0	0
$\omega_{1}^{\#2}{}_{\alpha}$	0	0	0	$\frac{t_1-2t_3}{3\sqrt{2}}$	$\frac{t_1 + t_3}{3}$	0	$-\frac{1}{3}\bar{l}k(t_1-2t_3)\Big -\frac{1}{3}\bar{l}\sqrt{2}k(t_1+t_3)\Big $
$\omega_{1^{-}}^{\#1}{}_{\alpha}$	0	0	0	$\frac{1}{6}(t_1+4t_3)$	$\frac{t_1-2t_3}{3\sqrt{2}}$	0	$-\frac{1}{3}ik(t_1-2t_3)$
$f_{1}^{\#1}\alpha\beta$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0	0	0
$\omega_{1}^{\#2}{}_{\alpha\beta}$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$\omega_{1}^{\#1}$ $\omega_{1}^{\#2}$ $\omega_{1}^{\#2}$ $\beta_{1}^{\#1}$	$+^{\alpha\beta} k^2 r_1 - \frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$\frac{i k t_1}{\sqrt{2}}$	0	0	0	0
	$\omega_1^{\#_1} +^{lphaeta}$	$\omega_1^{\#2} + \alpha^{eta}$	$f_{1}^{\#1} + \alpha \beta$	$\omega_{1}^{\#1} +^{\alpha}$	$\omega_1^{\#2} +^{lpha}$	$f_{1}^{\#1} \dagger^{lpha}$	$f_1^{\#2} + \alpha$

>	$\frac{2}{3} k^2 (t_1 + t_2)$		
>	0		
	$(t_1 + t_3)$	#1 .	$\omega_{0}^{\#1}$
>	ĭ √2 k		t_3 $i \sqrt{2} k t_3$
	$\left \frac{1}{3} \right $	$f_{0+}^{#2} \dagger$	0
>	$-\frac{1}{3}\bar{l}k(t_1-2t_3)\Big -\frac{1}{3}\bar{l}\sqrt{2}k(t_1+t_3)\Big $		0 e constra
<u> </u>	- 0	$\frac{SO(3)}{\tau_{0}^{\#2}} ==$	irreps 0
			$i k \sigma_{0+}^{\#1} ==$
<u> </u>	0	-	+2 <i>ik</i> σ ₁ -2
>	0	τ#1α	
		$\tau_1^{\#1} \alpha \beta$	$+ik \sigma_{1}^{\#2}$

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

 $-i\sqrt{2} kt_3$

 $2k^2t_3$

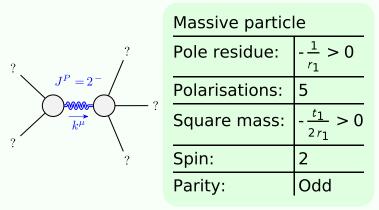
0 $-t_1$

$\omega_{2}^{\#1}_{\alpha\beta\chi}$	0	0	$k^2 r_1 + \frac{t_1}{2}$
$\omega_{2}^{\#1}_{+}$ $f_{2}^{\#1}_{+}$	$-\frac{i k t_1}{\sqrt{2}}$	$k^2 t_1$	0
	$\frac{t_1}{2}$	$\frac{ikt_1}{\sqrt{2}}$	0
·	$\omega_2^{\#1} + ^{lphaeta}$	$f_2^{#1} + ^{\alpha\beta}$	$\omega_{2}^{\#1} +^{lphaeta\chi}$

	$\sigma_{2}^{\#1}{}_{lphaeta}$	$ au_2^{\#1}{}_{lphaeta}$	$\sigma_{2}^{\#1}{}_{\alpha\beta\chi}$
$\sigma_{2}^{\#1} \dagger^{\alpha\beta}$	$\frac{2}{(1+2k^2)^2t_1}$	$-\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$	0
$ au_2^{\#1} \dagger^{lphaeta}$	$\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$	$\frac{4k^2}{(1+2k^2)^2t_1}$	0
$\sigma_2^{\#1}$ † $^{lphaeta\chi}$	0	0	$\frac{2}{2 k^2 r_1 + t_1}$

_	$\sigma_0^{\#1}$	$ au_0^{\#1}$	$ au_{0}^{\#2}$	$\sigma_0^{\#1}$
#1 0+ †	$\frac{1}{(1+2k^2)^2t_3}$	$-\frac{i\sqrt{2} k}{(1+2k^2)^2 t_3}$	0	0
#1 0+ †	$\frac{i\sqrt{2} k}{(1+2k^2)^2 t_3}$	$\frac{2k^2}{(1+2k^2)^2t_3}$	0	0
#2 0 ⁺ †	0	0	0	0
r ^{#1} †	0	0	0	$-\frac{1}{t_1}$

Massive and massless spectra



(No massless particles)

Unitarity conditions

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