Particle spectrograph

Wave operator and propagator

SO(3) irreps	Fundamental fields	Multiplicities
$\tau_0^{#2} == 0$	$\partial_{\beta}\partial_{\alpha}\tau^{\alpha\beta}==0$	1
$\tau_{0+}^{\#1} - 2 \bar{l} k \sigma_{0+}^{\#1} == 0$	$\partial_{\beta}\partial_{\alpha}\tau^{\alpha\beta} == \partial_{\beta}\partial^{\beta}\tau^{\alpha}_{\alpha} + 2\partial_{\chi}\partial^{\chi}\partial_{\beta}\sigma^{\alpha\beta}_{\alpha}$	1
$\tau_1^{\#2}{}^\alpha + 2ik \ \sigma_1^{\#2}{}^\alpha == 0$	$\partial_{\chi}\partial_{\beta}\partial^{\alpha}\tau^{\beta\chi} == \partial_{\chi}\partial^{\chi}\partial_{\beta}\tau^{\alpha\beta} + 2\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial_{\beta}\sigma^{\alpha\beta\chi}$	е
$t_{1}^{\#1}\alpha == 0$	$\partial_{\chi}\partial_{\beta}\partial^{\alpha}\tau^{\beta\chi} == \partial_{\chi}\partial^{\chi}\partial_{\beta}\tau^{\beta\alpha}$	8
$\tau_{1+}^{\#1}\alpha\beta + ik \ \sigma_{1+}^{\#1}\alpha\beta == 0$	$\partial_{\chi}\partial^{\alpha}\tau^{\beta\chi} + \partial_{\chi}\partial^{\beta}\tau^{\chi\alpha} + \partial_{\chi}\partial^{\chi}\tau^{\alpha\beta} +$	е
	$\partial_{\delta}\partial_{\chi}\partial^{\beta}\sigma^{\alpha\chi\delta} + \partial_{\delta}\partial^{\delta}\partial_{\chi}\sigma^{\beta\chi\alpha} = =$	
	$\partial_{\chi}\partial^{\alpha}\tau^{\chi\beta} + \partial_{\chi}\partial^{\beta}\tau^{\alpha\chi} + \partial_{\chi}\partial^{\chi}\tau^{\beta\alpha} +$	
	$\partial_{\delta}\partial_{\chi}\partial^{\alpha}\sigma^{eta\chi\delta}+\partial_{\delta}\partial^{\delta}\partial_{\chi}\sigma^{lpha\chieta}$	
$\sigma_{1+}^{\#1}\alpha\beta == \sigma_{1+}^{\#2}\alpha\beta$	$3 \partial_{\delta} \partial_{\chi} \partial^{\alpha} \sigma^{\beta \chi \delta} +$	8
	$2 \partial_{\delta} \partial^{\delta} \partial_{\chi} \sigma^{\alpha \beta \chi} + \partial_{\delta} \partial^{\delta} \partial_{\chi} \sigma^{\alpha \chi \beta} = =$	
	$3\partial_{\delta}\partial_{\chi}\partial^{\beta}\sigma^{\alpha\chi\delta} + \partial_{\delta}\partial^{\delta}\partial_{\chi}\sigma^{\beta\chi\alpha}$	
$\sigma_{2}^{\#1}\alpha\beta\chi==0$	$3 \partial_{\epsilon} \partial_{\delta} \partial^{\chi} \partial^{\alpha} \sigma^{\beta \delta \epsilon} + 3 \partial_{\epsilon} \partial^{\epsilon} \partial^{\chi} \partial^{\alpha} \sigma^{\beta \delta} +$	2
	$2 \partial_{\epsilon} \partial_{\epsilon} \partial_{\delta} \partial^{\beta} \sigma^{\alpha \chi \delta} + 4 \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\beta} \sigma^{\alpha \delta \chi} +$	
	$2 \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\beta} \sigma^{\chi \delta \alpha} + 4 \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\chi} \sigma^{\alpha \beta \delta} +$	
	$2 \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\chi} \sigma^{\alpha \delta \beta} + 2 \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\delta} \sigma^{\beta \chi \alpha} +$	
	$3 \eta^{eta\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial^\alpha \sigma^{\delta \epsilon}_{\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ $	
	$3 \eta^{\alpha\chi} \partial_{\phi} \partial^{\phi} \partial_{\epsilon} \partial_{\delta} \sigma^{\beta \delta \epsilon} +$	
	$3 \eta^{\beta \chi} \partial_{\phi} \partial^{\phi} \partial_{\epsilon} \partial^{\epsilon} \sigma^{\alpha \delta}{}_{\delta} ==$	
	$3 \partial_{\epsilon} \partial_{\delta} \partial^{\chi} \partial^{\beta} \sigma^{\alpha \delta \epsilon} + 3 \partial_{\epsilon} \partial^{\epsilon} \partial^{\chi} \partial^{\beta} \sigma^{\alpha \delta}{}_{\delta} +$	
	$2 \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\alpha} \sigma^{\beta \chi \delta} + 4 \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\alpha} \sigma^{\beta \delta \chi} +$	
	$2 \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\alpha} \sigma^{\chi \delta \beta} + 2 \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\chi} \sigma^{\beta \delta \alpha} +$	
	$4 \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\delta} \sigma^{\alpha \beta \chi} + 2 \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\delta} \sigma^{\alpha \chi \beta} +$	
	$3 \eta^{lpha\chi} \partial_{\phi} \partial^{\phi} \partial_{\epsilon} \partial^{eta} \sigma^{\delta \epsilon} +$	
	$3 \eta^{eta\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial_\delta \sigma^{lpha\delta\epsilon} +$	
	$3~\eta^{lpha\chi}~\partial_{\phi}\partial^{\phi}\partial_{\epsilon}\partial^{\epsilon}\sigma^{eta\delta}{}_{\delta}$	
$\tau_{2+}^{\#1}\alpha\beta==0$	$4 \partial_{\delta} \partial_{\chi} \partial^{\beta} \partial^{\alpha} t^{\chi \delta} + 2 \partial_{\delta} \partial^{\delta} \partial^{\beta} \partial^{\alpha} t^{\chi}_{\chi} +$	2
	$3\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\chi}\tau^{\alpha\beta} + 3\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\chi}\tau^{\beta\alpha} +$	
	$2 \eta^{\alpha\beta} \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial_{\chi} \tau^{\chi\delta} ==$	
	$3\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\alpha}\tau^{\beta\chi} + 3\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\alpha}\tau^{\chi\beta} +$	
	$3\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\beta}\tau^{\alpha\chi} + 3\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\beta}\tau^{\chi\alpha} +$	
	$2 \eta^{lphaeta} \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\delta} au_{\chi}^{\chi}$	
Total constraints/gauge	ige generators:	2.4

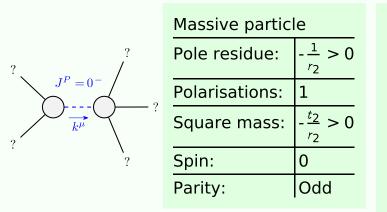
tion $ \begin{array}{ll} u_{\alpha} & \omega_{I}^{K} + 6 f^{\alpha\beta} \\ 8 t_{3} & \omega_{I}^{K} + 6 f^{\alpha\beta} \\ 8 t_{3} & \omega_{I}^{K} & \partial^{I} f^{I} \\ 9 t_{3} \partial_{I} \omega_{\beta}^{\beta} \partial^{\beta} f^{\alpha} \\ 18 t_{3} \partial_{I} \omega_{\alpha\beta}^{\beta} \partial^{\beta} f^{\alpha} \\ 2 t_{2} \partial_{\alpha} f_{\beta_{I}} \partial^{\beta} f^{\alpha} \partial^{\beta} f^{\alpha} \\ 2 t_{2} \omega_{\alpha I\beta} (\omega \omega_{\alpha\beta_{I}} \partial^{\beta} f^{\alpha} \partial^{\beta} f^$		$S == \iiint_{\epsilon} (-4t_3 \ \omega^{\alpha_l} \ \omega^{\kappa}_{l \ \kappa} + 6 \ f^{\alpha\beta} \ \tau_{\alpha\beta} + 6 \ \omega^{\alpha\beta\chi} \ \sigma_{\alpha\beta\chi} + 8t_3 \ \omega^{\kappa}_{\alpha \ \kappa} \ \partial_l f^{\alpha_l} -$	$8t_3\omega_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_$	$9 r_3 \partial_i \omega_{\beta}^{\ \ \theta} \partial^i \omega^{lpha eta} + 9 r_3 \partial_{lpha} \omega^{lpha eta_i} \partial_{eta} \omega_{eta}^{\ \ eta_i}$ -	$18r_3\partial'\omega^{lphaeta}_{\ \ lpha}\partial_{ heta}\omega^{eta}_{\ \ \ \ \ \ }$ - $15r_3\partial_{lpha}\omega^{lphaeta\prime}\partial_{ heta}\omega^{\ \ \ \ \ \ }_{\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ $	$30 r_3 \partial' \omega^{\alpha \beta}{}_{\alpha} \partial_{\theta} \omega'^{\theta}_{, \beta} + 4 t_2 \omega_{i \theta \alpha} \partial^{\theta} f^{\alpha i} + 2 t_2 \partial_{\alpha} f_{i \theta} \partial^{\theta} f^{\alpha i} -$	$t_2\partial_{lpha}f_{ heta_1}\partial^{ heta}f^{lpha_1}$ - $t_2\partial_i f_{lpha heta}\partial^{ heta}f^{lpha_I}+t_2\partial_{ heta}f_{lpha_I}\partial^{ heta}f^{lpha_I}$ -	$t_2 \partial_{\theta} f_{ \prime \alpha} \partial^{\theta} f^{ lpha \prime} - 4 t_2 \omega_{lpha heta \prime} \left(\omega^{lpha \prime heta} + \partial^{ heta} f^{ lpha \prime} \right) +$	$2t_2 \ \omega_{\alpha i \theta} \ (\omega^{\alpha i \theta} + 2 \partial^{\theta} f^{\alpha i}) + 8 r_2 \partial_{\beta} \omega_{\alpha i \theta} \partial^{\theta} \omega^{\alpha \beta i}$ -	$4r_2\partial_eta\omega_{lpha heta_I}\partial^ heta\omega^{lphaeta_I}+4r_2\partial_eta\omega_{Ietalpha}\partial^ heta\omega_{lphaeta}$ -	$24 r_3 \partial_{\beta} \omega_{\prime \theta \alpha} \partial^{\theta} \omega^{\alpha \beta \prime} - 2 r_2 \partial_{\prime} \omega_{\alpha \beta \theta} \partial^{\theta} \omega^{\alpha \beta \prime} +$	$2r_2\partial_ heta\omega_{lphaeta_!}\partial^ heta\omega^{lphaeta_!}$ - $4r_2\partial_ heta\omega_{lpha_!eta}\partial^ heta\omega_{lpha_!eta}$ +	$4t_3\partial_i f^{lpha_i}\partial_\kappa f_lpha^{} - 8t_3\partial^i f^lpha^{}\partial_\kappa f_lpha^{}))[t,\kappa,y,z]dzdyd\kappa dt$	
	Quadratic (free) action	$\alpha_{\alpha} \omega_{LK}^{K} + 6 f^{\alpha\beta}$	$8t_3 \omega_{/\kappa}^{\kappa} \partial^{\prime} f$	$9 r_3 \partial_i \omega_{\beta}^{\ \ \theta} \hat{c}$	$18r_3\partial'\omega^{lphaeta}_{c}$	$30 r_3 \partial' \omega^{\alpha \beta}$	$t_2 \partial_{\alpha} f_{ heta_I} \partial^{ heta} f^c$	$t_2 \partial_{\theta} f_{ I \alpha} \partial^{\theta} f^{c}$	$2t_2 \omega_{\alpha l \theta} (a_{\alpha l \theta})$	$4 r_2 \partial_{\beta} \omega_{\alpha \theta_l} \hat{c}$	$24 r_3 \partial_eta \omega_{_I heta_lpha}$	$2 r_2 \partial_\theta \omega_{\alpha \beta l} \hat{c}$	$4t_3\partial_i f^{lpha_i}\partial_\kappa f$	

$ au_1^{\#2}$	0	0	0	$-\frac{4i}{3kr_3+6k^3r_3}$	$\frac{i\sqrt{2}(9k^2r_3-4t_3)}{3k(1+2k^2)^2r_3t_3}$	0	$\frac{2(9k^2r_3-4t_3)}{3(1+2k^2)^2r_3t_3}$	f#1 f#2
$\tau_{1}^{\#1}{}_{\alpha}$	0	0	0	0	0	0	0	# <i>\$</i>
$\sigma_{1^-\alpha}^{\#2}$	0	0	$ \begin{array}{c c} 0 \\ 2 \sqrt{2} \\ 3 k^2 r_3 + 6 k^4 r_3 \\ 9 k^2 r_3 - 4 r_3 \end{array} $		$\frac{9k^2r_3-4t_3}{3(k+2k^3)^2r_3t_3}$	0	$-\frac{i\sqrt{2}(9k^2r_3-4t_3)}{3k(1+2k^2)^2r_3t_3}$	7#1"
$\sigma_{1^{-}\alpha}^{\#1}$	0	0	0	$-\frac{2}{3k^2r_3}$	$-\frac{2\sqrt{2}}{3k^2r_3+6k^4r_3}$	0	$\frac{4i}{3kr_3+6k^3r_3}$	1,41
$\tau_{1}^{\#1}{}_{\alpha\beta}$	$\frac{3i\sqrt{2}k}{(3+k^2)^2t_2}$	$\frac{3ik}{(3+k^2)^2t_2}$	$\frac{3k^2}{(3+k^2)^2t_2}$	0	0	0	0	$f^{#1}$
$\sigma_{1}^{\#2}{}_{lphaeta}$	$\frac{3\sqrt{2}}{(3+k^2)^2t_2}$	$\frac{3}{(3+k^2)^2 t_2}$	$-\frac{3ik}{(3+k^2)^2t_2}$	0	0	0	0	Z#(1)
$\sigma_{1}^{\#1}{}_{\alpha\beta}$	$\frac{6}{(3+k^2)^2 t_2}$	$\frac{3\sqrt{2}}{(3+k^2)^2t_2}$	$-\frac{3i\sqrt{2}k}{(3+k^2)^2t_2}$	0	0	0	0	(1)#1
	$\sigma_{1}^{\#1} + \alpha \beta$	$\sigma_{1}^{\#2} + \alpha^{\beta}$	$\tau_1^{\#1} + \alpha \beta$	$\sigma_{1}^{\#_1} +^{\alpha}$	$\sigma_1^{\#2} +^{lpha}$	$\tau_{1}^{\#1} +^{\alpha}$	$\tau_1^{\#2} +^{\alpha}$	

)	0	0	0	0	0	0	\mathcal{B}_{i}									
0	0	0	$-\frac{\sqrt{2}t_3}{3}$	<u>t3</u> 3	0	$-\frac{1}{3}\bar{l}\sqrt{2}kt_3$	$\omega_{2}^{\#1}_{\alpha\beta} \ f_{2}^{\#1}_{\alpha\beta}$	$\frac{3k^2r_3}{2} \qquad 0$	0 0	0 0	$\sigma_{2}^{\#1}$.		$\sigma_{2}^{\#1}\alpha\beta$ $\frac{2}{3k^2r_3}$	$\tau_{2}^{\#1}\alpha \mu$	$\sigma_{2}^{\#1}{}_{\alpha\beta}$	X
0	0	0	$\frac{1}{6} \left(-9 k^2 r_3 + 4 t_3 \right)$	$-\frac{\sqrt{2}t_3}{3}$	0	<u>2ikt3</u> 3		$\omega_2^{#1} + ^{\alpha\beta}$		$\omega_{2}^{#1} +^{\alpha\beta\chi}$	$ au_{2^{+}}^{\#1}$ $\sigma_{2^{-}}^{\#1}$ †		0	0	0	
			$\frac{1}{6}$ (-9 k^2				$\omega_{0^+}^{\#1}$		$\omega_{0}^{\#1}$ t_3		$\frac{f_0^{\#1}}{\sqrt{2} kt_3}$	$f_{0}^{#2}$	$\omega_{0}^{#1}$			_
3 " Y C N L 2	<i>ikt</i> 2 3	$\frac{k^2 t_2}{3}$	0	0	0	0	_	+ <u>i</u> v			$\frac{k^2 t_3}{0}$	0	0			
3 3 "	1 t 2 3	ikt_2	0	0	0	0	ω_{0}^{+1}	+	0		0	0	$k^2 r_2 +$			
	- -	- <u>1</u>))				$\sigma_{0}^{\#1}$		$\tau_{0}^{\#1}$	$ au_0^{\#}$	$\sigma_0^{2} + \sigma_0^{2}$	1		
3	$\frac{\sqrt{2} t_2}{3}$	$\sqrt{2} kt_2$	0	0	0	0	$\sigma_0^{\sharp 1}$	† (1+	1 2 k ²) ² t		$i \sqrt{2} k$ $1 + 2k^2)^2 t$		0			
(.,		$-\frac{1}{3}$ \tilde{I}					$ au_{0}^{\#1}$	†	$\frac{1}{2} \sqrt{2} k$ $2 k^2)^2 t$	÷ ₃ (1	$\frac{2k^2}{+2k^2)^2t}$	- (0			
_	$\dagger^{lphaeta}$	$\dagger^{\alpha \beta}$	$\omega_{1}^{\#1} +^{lpha}$	$\omega_{1}^{\#2} +^{lpha}$	$f_{1}^{\#1} \dagger^{lpha}$	$f_1^{\#2} +^{\alpha}$	$ au_{0}^{\#2}$	†	0		0	(0	1		
8 + -	$\omega_1^{\#2} + \alpha^{eta}$	$f_1^{\#1} + \alpha^{\beta}$	$\omega_{1^{\text{-}}}^{\#}$	$\omega_{1^{-}}^{\# \tilde{i}}$	$f_1^{\#}$	$f_1^{\#}$	$\sigma_0^{\#1}$	†	0		0	($\frac{1}{k^2 r_2}$	+t2		

 $\begin{array}{c|c}
0 & 0 \\
-\frac{2}{3}ikt_3 \\
\frac{1}{3}i\sqrt{2}kt_3 \\
0 & 0
\end{array}$

Massive and massless spectra



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

Unitarity conditions

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