Particle spectrograph

Wave operator and propagator

Source constraints		
SO(3) irreps	Fundamental fields	Multiplicities
$\tau_{0+}^{#2} == 0$	$\partial_{\beta}\partial_{\alpha}\tau^{\alpha\beta}==0$	1
$\tau_{0+}^{\#1} - 2 i k \sigma_{0+}^{\#1} == 0$	$\partial_{\beta}\partial_{\alpha}t^{\alpha\beta} == \partial_{\beta}\partial^{\beta}t^{\alpha}_{\alpha} + 2 \partial_{\chi}\partial^{\chi}\partial_{\beta}\sigma^{\alpha\beta}_{\alpha}$	1
$\tau_1^{\#2}\alpha + 2ik \ \sigma_1^{\#2}\alpha == 0$	$\partial_{\chi}\partial_{\beta}\partial^{\alpha}\tau^{\beta\chi} == \partial_{\chi}\partial^{\chi}\partial_{\beta}\tau^{\alpha\beta} + 2\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial_{\beta}\sigma^{\alpha\beta\chi}$	3
$\tau_{1}^{\#1}\alpha == 0$	$\partial_{\chi}\partial_{\beta}\partial^{\alpha}\tau^{\beta\chi} == \partial_{\chi}\partial^{\chi}\partial_{\beta}\tau^{\beta\alpha}$	3
$\tau_{1+}^{\#1}\alpha\beta + ik \ \sigma_{1+}^{\#2}\alpha\beta == 0$	$\partial_{\chi}\partial^{\alpha}\tau^{\beta\chi} + \partial_{\chi}\partial^{\beta}\tau^{\chi\alpha} + \partial_{\chi}\partial^{\chi}\tau^{\alpha\beta} +$	3
	$2 \partial_{\delta} \partial_{\chi} \partial^{\alpha} \sigma^{\beta \chi \delta} + 2 \partial_{\delta} \partial^{\delta} \partial_{\chi} \sigma^{\alpha \beta \chi} = =$	
	$\partial_{\chi}\partial^{\alpha}\tau^{\chi\beta} + \partial_{\chi}\partial^{\beta}\tau^{\alpha\chi} +$	
	$\partial_{\chi}\partial^{\chi} t^{\beta\alpha} + 2 \partial_{\delta}\partial_{\chi}\partial^{\beta}\sigma^{\alpha\chi\delta}$	
$\tau_{2+}^{\#1}\alpha\beta - 2ik \ \sigma_{2+}^{\#1}\alpha\beta == 0$	$-2ik \ \sigma_2^{\#1}{}^{\alpha\beta} == 0 \ -i(4 \partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2 \partial_\delta \partial^\delta \partial^\beta \sigma^{\tau\chi} -$	5
	$3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\alpha} \tau^{\beta \chi} - 3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\alpha} \tau^{\chi \beta} -$	
	$3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\beta} \tau^{\alpha \chi} - 3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\beta} \tau^{\chi \alpha} +$	
	$3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\chi} \tau^{\alpha \beta} + 3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\chi} \tau^{\beta \alpha} +$	
	$4\ ^{i}\ k^{\chi}\ \partial_{arepsilon}\partial_{\chi}\partial^{eta}\partial^{lpha}\sigma^{\deltaarepsilon}_{\ \ \delta}$ -	
	$6 i k^{\chi} \partial_{\epsilon} \partial_{\delta} \partial_{\chi} \partial^{\alpha} \sigma^{\beta \delta \epsilon}$ -	
	$6 i k^{\chi} \partial_{\epsilon} \partial_{\delta} \partial_{\chi} \partial^{\beta} \sigma^{\alpha \delta \epsilon} +$	
	$2 \eta^{\alpha\beta} \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial_{\chi} t^{\chi\delta} +$	
	$6 i k^{\chi} \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial_{\chi} \sigma^{\alpha \delta \beta} +$	
	$6\ i\ k^{\chi}\ \partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial_{\chi}\sigma^{eta\deltalpha}$ -	
	$2 \eta^{\alpha\beta} \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\delta} \iota^{\chi}_{\chi}$ -	
	$4 i \eta^{\alpha\beta} k^{\chi} \partial_{\phi} \partial^{\phi} \partial_{\epsilon} \partial_{\chi} \sigma^{\delta\epsilon}_{\delta}) == 0$	
Total constraints/gauge generators:	ge generators:	16

$ au_{1}^{\#1}$ $ au_{1}^{\#2}$	0 0	0 0	0 0	$\begin{array}{c c} \cdot & 0 & \frac{2ik}{t_1 + 2k^2t_1} \end{array}$	$\begin{bmatrix} - & 0 & \frac{i\sqrt{2}k}{(1+2k^2)^2t_1} \end{bmatrix}$	0 0	$\begin{bmatrix} -t_1 \\ t_1 \end{bmatrix} = 0 = \begin{bmatrix} 2k^2 \\ (1+2k^2)^2 t_1 \end{bmatrix}$		
$\sigma_{1}^{\#2}{}_{lpha}$	0	0	0	$\frac{\sqrt{2}}{t_1 + 2k^2t_1}$	$\frac{1}{(1+2k^2)^2t_1}$	0	$-\frac{i\sqrt{2}k}{(1+2k^2)^2t_1}$		
$\sigma_{1^{-}\alpha}^{\#1}$	0	0	0	0	$\frac{\sqrt{2}}{t_1 + 2k^2t_1}$	0	$-\frac{2ik}{t_1+2k^2t_1}$		
$\tau_{1}^{\#1}_{\alpha\beta}$	$-\frac{i\sqrt{2}k}{t_1+k^2t_1}$	$\frac{ik}{(1+k^2)^2 t_1}$	$\frac{k^2}{(1+k^2)^2 t_1}$	0	0	0	0		$\sigma_{\alpha \beta \chi}$ +
$\sigma_{1}^{\#2}{}_{lphaeta}$	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	$\frac{1}{(1+k^2)^2 t_1}$	$-\frac{ik}{(1+k^2)^2t_1}$	0	0	0	0	e) action	$S == \iiint (f^{\alpha\beta} \tau_{\alpha\beta} + \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} +$
$\sigma_{1}^{\#1}{}_{\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	$\frac{i\sqrt{2}k}{t_1+k^2t_1}$	0	0	0	0	Quadratic (free) action	$\iiint f^{\alpha\beta} \iota_{\alpha}$
	$\sigma_{1}^{\#1} + \alpha \beta$	$\sigma_1^{\#2} + \alpha \beta$	$\tau_1^{\#1} + \alpha \beta$	$\sigma_{1^{ar{-}}}^{\#_1} \dagger^{lpha}$	$\sigma_{1}^{\#2} +^{lpha}$	$\tau_{1}^{\#1} +^{\alpha}$	$t_1^{\#2} + \alpha$	Quadr	S== []

$\frac{1}{2}t_{1}(2\omega^{\alpha'}_{\alpha}\omega'_{\beta}^{\theta}-4\omega^{\theta}_{\alpha}\partial_{\beta}f^{\alpha'}+4\omega'_{\beta}^{\theta}\partial^{\beta}f^{\alpha}_{\alpha}-2\partial_{\beta}f^{\alpha'}\partial_{\beta}f^{\alpha'}+4\partial^{\beta}f^{\alpha}_{\alpha}\partial_{\beta}f^{\beta}_{\beta}-2\partial_{\alpha}f_{\beta}$ $2\partial_{\beta}f^{\theta}_{\beta}\partial^{\beta}f^{\alpha'}-\partial_{\alpha}f_{\beta}\partial^{\beta}f^{\alpha'}+\partial_{\beta}f^{\alpha}_{\alpha}+\partial_{\beta}f^{\alpha'}+\partial_{\delta}$	$\omega_{1}^{\#1} \alpha_{1}^{\#2} \omega_{1}^{\#2} f_{1}^{\#1} \alpha_{1}^{\#1} \alpha_{1}^{\#2} \omega_{1}^{\#2} f_{1}^{\#1} \alpha_{1}^{\#2} f_{1}^{\#2} \alpha_{1}^{2} \sigma_{1}^{4} \sigma_{1$
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_		$\sigma_{2^{+}lphaeta}^{\#1}$		$ au_{2}^{\#1}$	αβ	$\sigma_{2^{-}\alpha\beta\chi}^{\#1}$		
$\sigma_{2}^{\sharp 1} \dagger^{lphaeta}$		3	$\frac{2}{(1+2k^2)^2t_1}$		$-\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$		0	
$ au_{2^{+}}^{\#1} \dagger^{lphaeta}$		3	$\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$		$\frac{4k^2}{(1+2k^2)^2t_1}$		0	
$\sigma_2^{\#1}$	$\sigma_2^{\#1}$ † $^{lphaeta\chi}$		0		0		$\frac{2}{t_1}$	
×								
$\omega_{2}^{\#1}{}_{lphaeta}$	0		0	$\frac{\epsilon}{\Gamma_{2}}$	4			
$\omega_{2}^{\#1}$ $\omega_{2}^{\#1}$ $\alpha_{2}^{\#1}$ $\omega_{2}^{\#1}$ α_{2}	- <u>ikt1</u>	77	$k^2 t_1$	0				
$\omega_2^{\#1}_{+}$	<u>£1</u>	7		0				
	$^{t_1}_{+}$ $+^{\alpha\beta}$		$f_{2}^{#1} + \alpha \beta$	$_{1}+_{\alpha eta \chi}$				
	ω_{2}^{*1} 1	7	f_2^*	$\omega_{2}^{\#1} \dotplus$				
			$\omega_0^{\sharp 1}$		$f_{0+}^{\#1}$	$f_{0^{+}}^{#2}$	$\omega_0^{\sharp 1}$	
$\omega_{0^+}^{\#1}$	†		-t ₁	Ī.	$\sqrt{2} kt_1$	0	0	
$f_{0^{+}}^{#1}$	† -	Ī.	$\sqrt{2} kt$	1 -	$2 k^2 t_1$	0	0	
$f_{0+}^{#2}$	$f_{0+}^{#2}$ †		0		0	0	0	
$\omega_0^{\sharp 1}$	$\omega_{0}^{\#1}$ †		0		0	0	$k^2 r_2 - t_1$	

 $au_{0}^{\#2}$

 $\tau_{0}^{\#1}$

 $\frac{i \sqrt{2} k}{(1+2k^2)^2 t_1}$

 $-\frac{2k^2}{(1+2k^2)^2t_1}$

 ikt_1

0

0

 $f_{1}^{\#1} + \alpha \beta$ $\omega_{1}^{\#1} + \alpha$

0

0

 $\omega_{1}^{\#2} + ^{\alpha}$ $f_{1}^{\#1} + ^{\alpha}$ $f_{1}^{\#2} + ^{\alpha}$

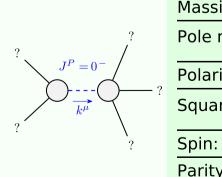
0

0

 $\frac{1}{(1+2k^2)^2t_1}$

 $-\frac{i\sqrt{2} k}{(1+2k^2)^2 t_1}$

Massive and massless spectra



	Massive particle							
- ?	Pole residue:	$-\frac{1}{r_2} > 0$	(No massless					
	Polarisations:	1	ssle					
	Square mass:	$\frac{t_1}{r_2} > 0$	-					
	Spin:	0	particles					
	Parity:	Odd	les)					

Unitarity conditions

 $r_2 < 0 \&\& t_1 < 0$