Particle spectrograph

Wave operator and propagator

Source constraints		
SO(3) irreps	Fundamental fields	Multiplicities
$\tau_{0+}^{\#2} == 0$	$\partial_{\beta}\partial_{\alpha}t^{\alpha\beta}==0$	1
$\tau_{0+}^{\#1} - 2 i k \sigma_{0+}^{\#1} == 0$	$\partial_{\beta}\partial_{\alpha}\tau^{\alpha\beta} == \partial_{\beta}\partial^{\beta}\tau^{\alpha}_{\alpha} + 2\partial_{\chi}\partial^{\chi}\partial_{\beta}\sigma^{\alpha\beta}_{\alpha}$	1
$\tau_{1}^{\#2}{}^{\alpha} + 2ik \ \sigma_{1}^{\#2}{}^{\alpha} = 0$	$\partial_{\chi}\partial_{\beta}\partial^{\alpha}\tau^{\beta\chi} == \partial_{\chi}\partial^{\chi}\partial_{\beta}\tau^{\alpha\beta} + 2\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial_{\beta}\sigma^{\alpha\beta\chi}$	8
$\tau_{1}^{\#1}{}^{\alpha} == 0$	$\partial_{\chi}\partial_{\beta}\partial^{\alpha}\tau^{\beta\chi} == \partial_{\chi}\partial^{\chi}\partial_{\beta}\tau^{\beta\alpha}$	3
$t_1^{\#1}\alpha\beta + ik \ \sigma_1^{\#2}\alpha\beta == 0$	$t_{1}^{\#1}\alpha\beta + ik \ \sigma_{1}^{\#2}\alpha\beta == 0 \partial_{\chi}\partial^{\alpha}t^{\beta\chi} + \partial_{\chi}\partial^{\beta}t^{\chi\alpha} + \partial_{\chi}\partial^{\chi}t^{\alpha\beta} +$	3
	$2 \partial_{\delta} \partial_{\chi} \partial^{\alpha} \sigma^{\beta \chi \delta} + 2 \partial_{\delta} \partial^{\delta} \partial_{\chi} \sigma^{\alpha \beta \chi} = =$	
	$\partial_{\chi}\partial^{\alpha} \tau^{\chi\beta} + \partial_{\chi}\partial^{\beta} \tau^{\alpha\chi} +$	
	$\partial_{\chi}\partial^{\chi}\tau^{\beta\alpha} + 2\partial_{\sigma}\partial_{\chi}\partial^{\beta}\sigma^{\alpha\chi\delta}$	
$\tau_{2+}^{\#1}\alpha\beta - 2ik \sigma_{2+}^{\#1}\alpha\beta == 0$	$-2ik \sigma_{2+}^{\#1}^{\#2} == 0 -i(4\partial_{\delta}\partial_{\chi}\partial^{\beta}\partial^{\alpha}\tau^{\chi\delta} + 2\partial_{\delta}\partial^{\delta}\partial^{\alpha}\tau^{\chi}_{\chi} -$	5
	$3 \partial_{\delta} \partial_{\chi} \partial^{\alpha} \tau^{eta \chi} - 3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\alpha} \tau^{\chi eta} -$	
	$3 \partial_{\delta} \partial_{\chi} \partial^{\beta} \tau^{\alpha \chi} - 3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\beta} \tau^{\chi \alpha} +$	
	$3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\chi} \tau^{\alpha\beta} + 3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\chi} \tau^{\beta\alpha} +$	
	$4\ i\ k^{\chi}\ \partial_{\epsilon}\partial_{\chi}\partial^{eta}\partial^{lpha}\sigma^{\deltaarepsilon}_{\ \ \delta}$ -	
	$6\ {\it i}\ k^{\chi}\ \partial_{\epsilon}\partial_{\delta}\partial_{\chi}\partial^{lpha}\sigma^{eta\deltaarepsilon}$ -	
	$6 i k^{\chi} \partial_{\epsilon} \partial_{\delta} \partial_{\chi} \partial^{\beta} \sigma^{\alpha \delta \epsilon} +$	
	$2 \eta^{\alpha\beta} \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial_{\chi} \tau^{\chi\delta} +$	
	$6 i k^{\chi} \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial_{\chi} \sigma^{\alpha \delta \beta} +$	
	6 i k^{χ} $\partial_{\epsilon}\partial^{\epsilon}\partial_{\delta}\partial_{\chi}\sigma^{eta\deltalpha}$ -	
	$2 \eta^{\alpha\beta} \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\delta} \tau_{\chi}^{\chi}$ -	
	$4 \mathbb{I} \eta^{\alpha\beta} k^{\chi} \partial_{\phi} \partial^{\phi} \partial_{\epsilon} \partial_{\chi} \sigma^{\delta \epsilon}_{ \delta}) == 0$	
Total constraints/gauge generators:	ge generators:	16

$8 r_2 \partial_eta \omega_{lpha_I eta} \partial^eta \omega^{lpha_{lpha_I}} - 4 r_2 \partial_eta \omega_{lpha_B} \partial^eta \omega^{lpha_{lpha_B}} + 4 r_2 \partial_eta \omega_{I eta lpha}$ $\partial^eta \omega^{lpha eta_I} - 2 r_2 \partial_I \omega_{lpha_B} \partial^eta \omega^{lpha eta_I} + 2 r_2 \partial_eta \omega_{lpha_B} \partial^eta \omega^{lpha_B} -$	$t_2 \partial_{\theta} f_{, lpha} \partial^{\sigma} f^{lpha'} + 2 (t_1 + t_2) \omega_{lpha' heta} (\omega^{lpha' \eta} + 2 \partial^{\sigma} f^{lpha'}) + \\ 2 \omega_{lpha heta_!} ((t_1 - 2 t_2) \omega^{lpha' heta} + 2 (2 t_1 - t_2) \partial^{\theta} f^{lpha'}) + \\ 8 r_2 \partial_{eta} \omega_{lpha' heta} \partial^{\theta} \omega^{lpha eta'} - 4 r_2 \partial_{eta} \omega_{lpha eta'} \partial^{\theta} \omega^{lpha eta'} + 4 r_2 \partial_{eta} \omega_{\iota lpha}$	$t_2 \partial_{lpha} f_{ heta_I} \partial^{ heta} f^{lpha_I} + 2 t_1 \partial_{ec{f}} f_{lpha heta} \partial^{ heta} f^{lpha_I} - t_2 \partial_{ec{f}} f_{lpha heta} \partial^{ heta} f^{lpha_I} + 1 \partial_{ec{g}} f_{lpha_I} \partial^{ heta} f^{lpha_I} + 2 f_1 \partial_{ heta} f_{lpha} \partial^{ heta} f^{lpha_I} - 1 \partial_{lpha} f_{lpha_I} \partial^{ heta} f_{lph} \partial^{ heta} f_{lpha_I} \partial^{ heta} f_{lpha_I} \partial^{ heta}$	$12t_1\partial'f^lpha_lpha\partial_ heta f_I^{\ eta}+4t_1\omega_{Ietalpha}\partial^ heta f^{lpha\prime}+4t_2\omega_{Ietalpha}\partial^ heta f^{lpha\prime} 4t_1\partial_lpha f_{Ieta}\partial^ heta f_{Ieta}\partial^ heta f^{lpha\prime}+2t_2\partial_lpha f_{Ieta}\partial^ heta f^{lpha\prime}-4t_1\partial_lpha f_{eta\prime}\partial^ heta f_{lpha\prime}\partial^ heta f_{lpha\prime}$	$\iiint (\frac{1}{6} \left(6t_1 \ \omega^{\alpha \prime}_{\alpha} \ \omega^{ \theta}_{\prime \ \theta} + 6 \ f^{\alpha \beta} \ \tau_{\alpha \beta} + 6 \ \omega^{\alpha \beta \chi} \ \sigma_{\alpha \beta \chi} - 12 t_1 \ \omega^{ \theta}_{\alpha \ \theta} \ \partial_{\prime} f^{\alpha \prime} + 12 t_1 \\ \omega^{ \theta}_{\prime \ \theta} \ \partial^{\prime} f^{\alpha}_{\alpha} - 6 t_1 \partial_{\prime} f^{ \theta}_{\alpha} \partial^{\prime} f^{\alpha}_{\alpha} - 6 t_1 \partial_{\prime} f^{ \theta}_{\alpha} + 6 t_1 \partial_{\prime} f^{ \alpha}_{\alpha} \partial_{\theta} f^{ \alpha}_{\alpha} + 6 t_1 \partial_{\prime} f^{ \alpha}_{\alpha} \partial_{\theta} f^{ \alpha}_{\alpha} + 6 t_1 \partial_{\prime} f^{ \alpha}_{\alpha} \partial_{\theta} f^{ \alpha}_{$	Quadratic (free) action $S ==$	tion $ \omega_{,\theta}^{\theta} + 6f^{\alpha\beta} \tau_{\alpha\beta} + 6\omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - 12t_1\omega_{\alpha}^{\theta}\partial_i f^{\alpha i} + 12t_1 $ $ \omega_{,\theta}^{\theta}\partial^i f^{\alpha}_{\alpha} - 6t_1\partial_i f^{\theta}_{\theta}\partial^i f^{\alpha i} - 6t_1\partial_i f^{\alpha i}\partial_\theta f^{\alpha i} + $ $ 12t_1\partial^i f^{\alpha}_{\alpha}\partial_\theta f^{i} + 4t_1\omega_{\theta\alpha}\partial^\theta f^{\alpha i} + 4t_2\omega_{\theta\alpha}\partial^\theta f^{\alpha i} - $ $ 4t_1\partial_\alpha f_{i\theta}\partial^\theta f^{\alpha i} + 2t_2\partial_\alpha f_{i\theta}\partial^\theta f^{\alpha i} - t_2\partial_i f_{\alpha\theta}\partial^\theta f^{\alpha i} - $ $ t_2\partial_\alpha f_{\theta i}\partial^\theta f^{\alpha i} + 2t_1\partial_i f_{\alpha\theta}\partial^\theta f^{\alpha i} - t_2\partial_i f_{\alpha\theta}\partial^\theta f^{\alpha i} - $ $ t_2\partial_\alpha f_{\theta i}\partial^\theta f^{\alpha i} + 2t_1\partial_i f_{\alpha\theta}\partial^\theta f^{\alpha i} + 2t_1\partial_\theta f_{\alpha}\partial^\theta f^{\alpha i} - $ $ t_2\partial_\theta f_{\alpha i}\partial^\theta f^{\alpha i} + 2t_1\partial_i f_{\alpha\theta}\partial^\theta f^{\alpha i} + 2t_1\partial_\theta f_{\alpha}\partial^\theta f^{\alpha i} - $ $ t_2\partial_\theta f_{\alpha i}\partial^\theta f^{\alpha i} + 2t_1\partial_i f_{\alpha\theta}\partial^\theta f^{\alpha i} + 2t_1\partial_\theta f_{\alpha i}\partial^\theta f^{\alpha i} - $ $ t_2\partial_\theta f_{\alpha i}\partial^\theta f^{\alpha i} + 2t_1\partial_i f_{\alpha\theta}\partial^\theta f^{\alpha i} + 2t_1\partial_\theta f_{\alpha i}\partial^\theta f^{\alpha i} - $ $ t_2\partial_\theta f_{\alpha i}\partial^\theta f^{\alpha i} + 2t_1\partial_i f_{\alpha\theta}\partial^\theta f^{\alpha i} + 2t_1\partial_\theta f_{\alpha i}\partial^\theta f^{\alpha i} + 2\partial_\theta f^{\alpha i} - $ $ t_2\partial_\theta f_{\alpha i}\partial^\theta f^{\alpha i} + 2t_2\partial_\theta f^{\alpha i}\partial^\theta f^{\alpha i} + 2t_2\partial_\theta f^{\alpha i} + 2\partial_\theta f^{\alpha i} - $ $ t_2\partial_\theta f_{\alpha i}\partial^\theta f^{\alpha i} + 2t_2\partial_\theta f^{\alpha i}\partial^\theta f^{\alpha i} + 2t_2\partial_\theta f^{\alpha i} + 2\partial_\theta f^{\alpha i}\partial^\theta f^{\alpha i} + 2\partial_\theta f^{\alpha i}\partial^\theta f^{\alpha i} - $ $ t_2\partial_\theta f_{\alpha i}\partial^\theta f^{\alpha i} + 2t_2\partial_\theta f^{\alpha i}\partial^\theta f^{\alpha i} + 2t_2\partial_\theta f^{\alpha i}\partial^\theta f^{\alpha i} + 2\partial_\theta f^{\alpha i}\partial^\theta f^{\alpha i}\partial^\theta f^{\alpha i} + 2\partial_\theta f^{\alpha i}\partial^\theta f^{\alpha i} + 2\partial_\theta f^{\alpha i}\partial^\theta f^{\alpha i}\partial^\theta f^{\alpha i} + 2\partial_\theta f^{\alpha i}\partial^\theta f^{\alpha i}\partial^\theta f^{\alpha i} + 2\partial_\theta f^{\alpha i}\partial^\theta f^{\alpha $
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 $\tau_{1}^{\#1}{}_{\alpha}$

						-																		
0	0	0	0	0	0	0	α				-													
			t ₁	2 t1		$\frac{k}{2t_1}$	$f_{1}^{\#2}$	0	0	0	īkt ₁	0	0	0									2	l
0	0	0	$\frac{\sqrt{2}}{t_1 + 2k^2t_1}$	$\frac{1}{(1+2k^2)^2t_1}$	0	$\frac{i\sqrt{2}k}{(1+2k^2)^2t_1}$	$_{lpha}$ $f_{1^{-}}^{\#1}$	0	0	0	0	0	0	0	$\sigma_{2^{-}}^{\#1}{}_{lphaeta\chi}$	0	0	$\frac{2}{t_1}$	$\omega_{0}^{\#1}$	0	0	0	2 $r_{2} + t_{2}$	
				1.5		<u>'</u>	$\omega_{1^{-}}^{\#2}$	0	0	0	$\frac{t_1}{\sqrt{2}}$	0	0	0		$\frac{k}{t_1}$			$f_{0}^{#2}$	0	0	0	0 k ²	
0	0	0	0	$\frac{\sqrt{2}}{t_1 + 2k^2}$	0	$-\frac{2ik}{t_1+2k^2t_1}$	$\omega_{1^{-}\alpha}^{\#1}$	0	0	0	- 1 1	$\frac{t_1}{\sqrt{2}}$	0	$-ikt_1$	$\tau_{2}^{\#1}{}_{\alpha\beta}$	$\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$	$\frac{4k^2}{(1+2k^2)^2t_1}$	0		$i\sqrt{2} kt_1$	$2k^2t_1$			
$\frac{2t_2)}{1t_2}$	t2) t1 t2	$\frac{t_2)}{t_1t_2}$					3	(2)	- t ₂)	- t ₂)									$f_{0}^{\#1}$	<i>i</i> √2	-2 k	0	0	
$\frac{i\sqrt{2} k(t_1-2t_2)}{3(1+k^2)t_1t_2}$	$\frac{i k (t_1 + 4 t_2)}{3 (1 + k^2)^2 t_1 t_2}$	$\frac{k^2 (t_1 + 4t_2)}{3 (1 + k^2)^2 t_1 t_2}$	0	0	0	0	$f_{1}^{\#1}{}_{lphaeta}$	$-\frac{ik(t_1-2t_2)}{3\sqrt{2}}$	$\frac{1}{3}\tilde{l}k(t_1+t_2)$	$\frac{1}{3}k^{2}(t_{1}+t_{2})$	0	0	0	0	$\sigma_{2}^{\#1}{}_{\alpha\beta}$	$\frac{2}{(1+2k^2)^2t_1}$	$\frac{2 i \sqrt{2} k}{(1+2 k^2)^2 t_1}$	0	$\omega_{0}^{\#1}$	-t ₁	$\sqrt{2} kt_1$	0	0	
$\frac{\sqrt{2} (t_1 - 2t_2)}{3 (1 + k^2) t_1 t_2}$	$\frac{t_1+4t_2}{3(1+k^2)^2t_1t_2}$	$\frac{i k (t_1 + 4t_2)}{3 (1 + k^2)^2 t_1 t_2}$	0	0	0	0	$\omega_{1}^{\#2}{}_{\alpha\beta}$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	#1+t2 3	$\tilde{l} k (t_1 + t_2)$	0	0	0	0		$\sigma_{2}^{\#1} + \alpha \beta$	$\tau_{2}^{\#1} + \alpha \beta$	$\sigma_{2}^{\#1} +^{\alpha \beta \chi}$		$\omega_{0}^{\#1}$ †	$f_{0}^{#1} + -i$		$\omega_{0^-}^{\#1} \dagger$	
~ m	3 (i						·		- <u>1</u> <u>i</u>							$\sigma_{0}^{#1}$		$\tau_{0}^{\#1}$	τ	#2 0 ⁺	$\sigma_0^{\#1}$	_	
$\frac{-t_2}{t_2}$	$\frac{-2t_2)}{t_1t_2}$	$\frac{1-2t_2}{t_1t_2}$					$_{lphaeta}$	4 t ₂)	2 <u>7</u> 2	t2)					$\sigma_{0}^{\sharp 1}$	† - 	$\frac{1}{(+2k^2)^2t}$	_	$\frac{i\sqrt{2}k}{(2k^2)^2}$	$\frac{1}{t_1}$	0	0		
$\frac{2(t_1+t_2)}{3t_1t_2}$	$\frac{\sqrt{2} (t_1 - 2t_2)}{3 (1 + k^2) t_1 t_2}$	$\frac{i\sqrt{2}k(t_1-2t_2)}{3(1+k^2)t_1t_2}$	0	0	0	0	$\omega_1^{\#1}_+{}_{\alpha\beta}$	$\frac{1}{6}(t_1+4t_2)$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$\frac{i k (t_1 - 2t_2)}{3 \sqrt{2}}$	0	0	0	0	$ au_{0}^{\#1}$	+ - (1-	i √2 k +2 k ²) ² t		$2k^2 + 2k^2)^2$		0	0		
$+^{\alpha\beta}$	$+^{\alpha\beta}$	$+^{\alpha\beta}$	$\sigma_{1}^{\#1} +^{lpha}$	$\sigma_{1}^{\#2} +^{\alpha}$	$\tau_{1}^{\#_{1}} + \alpha$	$\tau_1^{\#2} + \alpha$		$+\alpha\beta$	$+\alpha\beta$	$+^{\alpha\beta}$	τ+α	+α	$f_{1}^{\#1} \dagger^{\alpha}$	$f_{1}^{\#2} +^{\alpha}$	$\tau_{0}^{\#2}$	†	0		0		0	0		= 17+-
$\sigma_{1}^{*1} + \alpha^{eta}$	$\sigma_1^{\#_2} + \alpha^\beta$	$\tau_{1}^{#1} + \alpha \beta$	$\sigma_{1^{\bar{-}}}^{\#1}$	$\sigma_{1}^{\#2}$	$t_1^{\#1}$	1 ₁ -		$\omega_1^{#1} + ^{lphaeta}$	$\omega_1^{\#_2^2} +^{lphaeta}$	$f_1^{#1} + \alpha \beta$	$\omega_{1}^{\#1} +^{\alpha}$	$\omega_{1}^{\#2} +^{lpha}$	$f_{1}^{\#1}$	$f_1^{#2}$	$\sigma_0^{\#1}$	†	0		0		0 -	$\frac{1}{k^2 r_2 + t_2}$	2	*

0 0 0 2

 $\frac{t_1}{2}$ $\frac{2}{\sqrt{2}}$ 0

Massive and massless spectra

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

(No massless particles)

Unitarity conditions

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