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
$\tau_0^{#1} == 0$	$\partial_{\beta}\partial_{\alpha}\tau^{\alpha\beta} == \partial_{\beta}\partial^{\beta}\tau^{\alpha}$	1
$\tau_{1}^{\#2}\alpha + 2ik \ \sigma_{1}^{\#1}\alpha = 0$	$\partial_{\chi}\partial_{\beta}\partial^{\alpha}\tau^{\beta\chi}$ +	3
	$2 \left(\partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\alpha} \sigma^{\beta \chi} - \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial_{\beta} \sigma^{\alpha \beta \chi} + \right)$	
	$\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial^{\chi}\sigma^{\alpha\beta}_{\ \ eta}$) == $\partial_{\chi}\partial^{\chi}\partial^{\chi}\partial_{\beta}\tau^{\alpha\beta}$	
$\tau_{1}^{\#1}{}^{\alpha} == 0$	$\partial_{\chi}\partial_{\beta}\partial^{\alpha}\tau^{\beta\chi} == \partial_{\chi}\partial^{\chi}\partial_{\beta}\tau^{\beta\alpha}$	8
$\sigma_{1}^{\#1}{}^{\alpha} == \sigma_{1}^{\#2}{}^{\alpha}$	$\partial_{\chi} \partial^{\alpha} \sigma^{\beta \chi}_{\beta} + \partial_{\chi} \partial^{\chi} \sigma^{\alpha \beta}_{\beta} == 0$	8
$\tau_{1}^{\#1}\alpha\beta + ik \ \sigma_{1}^{\#2}\alpha\beta == 0$	$\partial_{\chi}\partial^{\alpha}\tau^{\beta\chi} + \partial_{\chi}\partial^{\beta}\tau^{\chi\alpha} + \partial_{\chi}\partial^{\chi}\tau^{\alpha\beta} +$	3
	$2 \partial_{\delta} \partial_{\chi} \partial^{\alpha} \sigma^{\beta \chi \delta} + 2 \partial_{\delta} \partial^{\delta} \partial_{\chi} \sigma^{\alpha \beta \chi} = =$	
	$\partial_{\chi}\partial^{\alpha}\tau^{\chi\beta} + \partial_{\chi}\partial^{\beta}\tau^{\alpha\chi} +$	
	$\partial_{\chi}\partial^{\chi}\tau^{\beta\alpha} + 2\partial_{\delta}\partial_{\chi}\partial^{\beta}\sigma^{\alpha\chi\delta}$	
$\tau_{2+}^{\#1}\alpha\beta - 2ik \sigma_{2+}^{\#1}\alpha\beta == 0$	$\tau_{2}^{\#1}\alpha\beta - 2ik \sigma_{2}^{\#1}\alpha\beta == 0 - i(4 \partial_{\delta}\partial_{\chi}\partial^{\beta}\partial^{\alpha}\tau^{\chi\delta} + 2 \partial_{\delta}\partial^{\delta}\partial^{\alpha}\tau^{\chi} -$	5
	$3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\alpha} \tau^{\beta \chi} - 3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\alpha} \tau^{\chi \beta} -$	
	$3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\beta} \tau^{\alpha \chi} - 3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\beta} \tau^{\chi \alpha} +$	
	$3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\chi} \tau^{\alpha\beta} + 3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\chi} \tau^{\beta\alpha} +$	
	$4\ i \ k^{\chi} \ \partial_{\epsilon}\partial_{\chi}\partial^{eta}\partial^{lpha}\sigma^{\delta arepsilon}_{\ \delta}$ -	
	$6 i k^{\chi} \partial_{\epsilon} \partial_{\delta} \partial_{\chi} \partial^{\alpha} \sigma^{\beta \delta \epsilon}$ -	
	$6 i k^{\chi} \partial_{\epsilon} \partial_{\delta} \partial_{\chi} \partial^{\beta} \sigma^{\alpha \delta \epsilon} +$	
	$2 \eta^{\alpha\beta} \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial_{\chi} t^{\chi\delta} +$	
	$6 i k^{\chi} \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial_{\chi} \sigma^{\alpha \delta \beta} +$	
	$6 \ i \ k^{\chi} \ \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial_{\chi} \sigma^{eta \delta lpha}$ -	
	$2 \eta^{\alpha\beta} \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\delta} v_{\chi}^{\chi}$ -	
	$4 i \eta^{\alpha\beta} k^X \partial_\phi \partial^\phi \partial_\epsilon \partial_\chi \sigma^{\delta\epsilon}_{\delta}) == 0$	
Total constraints/gauge generators:	ge generators:	19

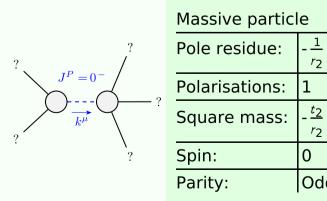
	$^{\prime \chi}$ $\sigma_{lpha eta \chi}$ -	$^{\theta}_{\theta} \partial' f^{\alpha}_{\alpha} - 2 t_1 \partial_i f^{\theta}_{\theta} \partial' f^{\alpha}_{\alpha} -$	$24 r_3 \partial_{\beta} \mathcal{R}_{\beta}^{\ \theta} \partial^{\prime} \mathcal{R}^{\alpha \beta}_{\alpha} - 2 t_1 \partial_{\prime} f^{\alpha \prime} \partial_{\theta} f_{\alpha}^{\ \theta} + 4 t_1 \partial^{\prime} f^{\alpha}_{\alpha} \partial_{\theta} f_{\beta}^{\ \theta} -$	$^{\prime}$ $^{\prime}$ 3 3 3 3 3 3 3 3 4 4 4	$4t_1\mathcal{R}_{' hetalpha}\partial^{ heta}f^{lpha\prime}+4t_2\mathcal{R}_{' hetalpha}\partial^{ heta}f^{lpha\prime}$ $-4t_1\partial_{lpha}f_{'lpha}\partial^{ heta}f^{lpha\prime}$ $+$	$\partial^{\theta}f^{\alpha\prime}$ - $t_{2}\partial_{\alpha}f_{ heta_{\prime}}\partial^{ heta}f^{lpha\prime}$ +	$^{1}\theta f^{lpha\prime}+4t_{1}\partial_{ heta}f_{lpha\prime}\partial^{ heta}f^{lpha\prime}+$	$\partial^{ heta}f^{lpha\prime}$ - t_{2} $\partial_{ heta}f_{\primelpha}$ $\partial^{ heta}f^{lpha\prime}$ +	$2 \partial^{\theta} f^{\alpha \prime}) +$	$2(2t_1-t_2)\partial^{\theta}f^{\alpha\prime})+$	$^{1}_{eta}\mathcal{A}_{lpha heta_{l}}\partial^{ heta}\mathcal{A}^{lphaeta_{l}}+$	$\partial_{eta} {\mathcal A}_{eta eta} \partial^{ heta} {\mathcal A}^{lpha eta_{eta}}$ -	$\partial_{ heta} \mathcal{A}_{lphaeta_l} \partial^{ heta} \mathcal{A}^{lphaeta_l}$ -	y, z]dzdydxdt	
tion	$S == \iiint (\frac{1}{6} (2t_1 \mathcal{A}^{\alpha})^{\alpha} \mathcal{A}_{\alpha}^{\theta} + 6 f^{\alpha\beta} t_{\alpha\beta} + 6 \mathcal{A}^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} -$	$4t_1\mathcal{A}_{\alpha\ \theta}^{\ \theta}\partial_{i}f^{\alpha\prime}+4t_1\mathcal{A}_{i}^{\ \theta}\partial^{\prime}f^{\alpha}_{\ \alpha}-2t_1\partial_{i}f^{\theta}_{\ \theta}\partial^{\prime}f^{\alpha}_{\ \alpha}-$	$24 r_3 \partial_{eta} \mathcal{A}^{\; heta}_{\; \; \; heta} \partial^{}_{} \mathcal{A}^{lpha eta}_{\; \; \; \; } - 2 t_1 \delta^{}_{}$	$24 r_3 \partial_{\alpha} \mathcal{R}^{\alpha\beta'} \partial_{\theta} \mathcal{R}'^{\theta}_{\beta} + 48 r_3 \partial' \mathcal{R}^{\alpha\beta}_{\alpha} \partial_{\theta} \mathcal{R}'^{\theta}_{\beta} +$	$4t_1{\cal R}_{_{I} hetalpha}\partial^{ heta}\!f^{lpha_{I}}\!+\!4t_2{\cal R}_{_{I} heta}$	$2t_2 \partial_{\alpha} f_{,\theta} \partial^{\theta} f^{\alpha \prime} - 4t_1 \partial_{\alpha} f_{\theta \prime} \partial^{\theta} f^{\alpha \prime} - t_2 \partial_{\alpha} f_{\theta \prime} \partial^{\theta} f^{\alpha \prime} +$	$2t_1\partial_{\scriptscriptstyle{i}} f_{\alpha\theta}\partial^{\theta} f^{\alpha\prime} - t_2\partial_{\scriptscriptstyle{i}} f_{\alpha\theta}\partial^{\theta} f^{\alpha\prime} + 4t_1\partial_{\theta} f_{\alpha\prime}\partial^{\theta} f^{\alpha\prime} +$	$t_2 \partial_{\theta} f_{\alpha_{I}} \partial^{\theta} f^{\alpha_{I}} + 2 t_1 \partial_{\theta} f_{I\alpha} \partial^{\theta} f^{\alpha_{I}} - t_2 \partial_{\theta} f_{I\alpha} \partial^{\theta} f^{\alpha_{I}} +$	$2(t_1+t_2)\mathcal{A}_{\alpha\prime\theta}(\mathcal{A}^{\alpha\prime\theta}+2\partial^{\theta}f^{\alpha\prime})+$	$2 \mathcal{A}_{\alpha\theta}$, $((t_1 - 2t_2) \mathcal{A}^{\alpha l\theta} + 2(2t_1 - t_2) \partial^{\theta} f^{\alpha l}) +$	$8r_2\partial_{eta}\mathcal{R}_{lpha\prime heta}\partial^{artheta}\mathcal{R}^{lphaeta\prime}$ - $4r_2\partial_{eta}\mathcal{R}_{lpha heta\prime}$ $\partial^{artheta}\mathcal{R}^{lphaeta\prime}$ +	$4 r_2 \partial_{\beta} \mathcal{A}_{, heta lpha} \partial^{ heta} \mathcal{A}^{lpha eta_!} - 24 r_3 \partial_{eta} \mathcal{A}_{, heta lpha} \partial^{ heta} \mathcal{A}^{lpha eta_!} -$	$2 r_2 \partial_{\beta} \mathcal{R}_{\alpha \beta \theta} \partial^{\theta} \mathcal{R}^{\alpha \beta \prime} + 2 r_2 \partial_{\theta} \mathcal{R}_{\alpha \beta \prime} \partial^{\theta} \mathcal{R}^{\alpha \beta \prime}$ -	$4 r_2 \partial_{\theta} \mathcal{A}_{\alpha \prime \beta} \partial^{\theta} \mathcal{A}^{\alpha \beta \prime}))[t, x, y, z] dz dy dx dt$	
Quadratic (free) action	$S == \iiint \left(\frac{1}{6} \left(2 t_1 \mathcal{A}^{\alpha} \right) \right)$														

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$ au_{1}^{\#2}$	0	0	0	$\frac{12ik}{(3+4k^2)^2t_1}$	$\frac{12i\sqrt{2}k}{(3+4k^2)^2t_1}$	0	$\frac{24k^2}{(3+4k^2)^2t_1}$	$f_{1}^{#2}$	0	0	0	<u>i kt1</u> 3	$\frac{1}{3}\bar{l}\sqrt{2}kt_1$	0	$\frac{2k^2t_1}{3}$	ć
$ au_{1}^{\#1}$	0	0	0	0	0	0	0	$f_{1^-}^{\#1} lpha$	0	0	0	0	0	0	0	${\mathscr F}$
$\sigma_{1}^{\#2}$	0	0	0	$\frac{6\sqrt{2}}{(3+4k^2)^2t_1}$	$\frac{12}{(3+4k^2)^2t_1}$	0	$-\frac{12i\sqrt{2}k}{(3+4k^2)^2t_1}$	${\mathcal A}_{1^-lpha}^{\#2}$)	0	0	0	$\frac{t_1}{3\sqrt{2}}$	1 1 2	0	$\frac{1}{3}\bar{l}\sqrt{2}kt_1$	F
$\sigma_{1^{\text{-}}}^{\#1}{}_{\alpha}$	0	0	0	$\frac{6}{(3+4k^2)^2t_1}$	$\frac{6\sqrt{2}}{(3+4k^2)^2t_1}$	0	$-\frac{12ik}{(3+4k^2)^2t_1}$	${\mathscr{A}}_{1^{\text{-}}\alpha}^{\#1}$	0	0	0	1 1 6	$\frac{t_1}{3\sqrt{2}}$	0	$-\frac{1}{3}ikt_1$	I I F
$\tau_{1}^{\#1}_{+}$	$\frac{i\sqrt{2} k(t_1-2t_2)}{3(1+k^2)t_1t_2}$	$\frac{i k (t_1 + 4t_2)}{3 (1 + k^2)^2 t_1 t_2}$	$\frac{k^2 (t_1 + 4t_2)}{3 (1 + k^2)^2 t_1 t_2}$	0	0	0	0	$f_{1}^{\#1}{}_{lphaeta}$	$-\frac{ik(t_1-2t_2)}{3\sqrt{2}}$	$\frac{1}{3}\overline{l}k(t_1+t_2)$	$\frac{1}{3} k^2 (t_1 + t_2)$	0	0	0	0	σ_0^{i}
$\sigma_{1}^{\#2}$	$\frac{\sqrt{2} (t_1 - 2t_2)}{3 (1 + k^2) t_1 t_2}$	$\frac{t_1+4t_2}{3(1+k^2)^2t_1t_2}$	$-\frac{ik(t_1+4t_2)}{3(1+k^2)^2t_1t_2}$	0	0	0	0	${\mathscr A}_{1}^{\#_{2}^{2}}$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$\frac{t_1+t_2}{3}$	$-\frac{1}{3}\bar{l}k(t_1+t_2)$	0	0	0	0	τ_0^{i} σ_0^{i}
$\sigma_{1}^{\#1}$	$\frac{2(t_1+t_2)}{3t_1t_2}$	$\frac{\sqrt{2} (t_1 - 2t_2)}{3 (1 + k^2) t_1 t_2}$	$-\frac{i\sqrt{2}k(t_1-2t_2)}{3(1+k^2)t_1t_2}$	0	0	0	0	${\mathscr A}_{1}^{\#1}{}_{\alpha\beta}$	$\frac{1}{6}(t_1+4t_2)$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$\frac{i k (t_1 - 2t_2)}{3 \sqrt{2}}$	0	0	0	0	Ó
	$\sigma_1^{\#1} + \alpha \beta$	$\sigma_1^{\#2} + ^{lphaeta}$	$\tau_1^{\#1} + \alpha \beta$	$\sigma_{1^-}^{\#_1} +^\alpha$	$\sigma_{1}^{\#2} +^{lpha}$	$\tau_{1}^{\#_{1}} +^{\alpha}$	$\tau_{1}^{\#2} + \alpha$		$\mathcal{A}_1^{\#1} +^{lphaeta}$	$\mathcal{A}_1^{\#_2} +^{\alpha \beta}$	$f_1^{#1} + \alpha \beta$	$\mathcal{A}_{1^{\bar{-}}}^{\#1} +^{\alpha}$	$\mathcal{A}_{1^{\bar{-}}}^{\#2} +^{\alpha}$	$f_{1^{\bar{-}}}^{\#1} +^{\alpha}$	$f_1^{\#2} +^{\alpha}$	σ

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'	0	0	0	0	0	0	$\mathcal{A}_2^{\sharp 1}$ †	αβχ	()	0		<u>t</u> 1 2		
,	0	0	$\frac{t_1}{3\sqrt{2}}$	<u>†1</u> 3	0	$-\frac{1}{3}\bar{l}\sqrt{2}kt_1$	${\cal R}_0^{\#1}\dagger$	6 k		f ₀ ^{#1} 0	0		$\mathcal{A}_0^{\sharp 1}$		
,	0	0	9 <u>T</u> 7	$\frac{t_1}{3\sqrt{2}}$	0	$-\frac{1}{3}\bar{l}kt_1 \bigg -$	$f_{0^{+}}^{#1}\dagger$ $f_{0^{+}}^{#2}\dagger$		0	0 0	0		$0 \\ 0 \\ r_2 +$	<i>+</i> _	
3 √2	$\frac{1}{3}$ \bar{l} k $(t_1 + t_2)$	$\frac{1}{3}k^{2}(t_{1}+t_{2})$	0	0	0	0	$\sigma_{0^+}^{\sharp 1}$ †	$\sigma_0^{\#}$ $\frac{1}{6 k^2}$	1 + 1		τ ₀ ^{#2}	σ_0^{t}	#1) ⁻	62	
3 √2	$\frac{t_1+t_2}{3}$	$-\frac{1}{3}\tilde{l}k(t_1+t_2)$	0	0	0	0	$ au_{0+}^{\#1} + au_{0+}^{\#2} + au_{0+}^{\#2} + au_{0-}^{\#1} + au_{0-}^{\#1$	0 0		0 0	0 0 0	$\frac{C}{k^2 r_2}$)		
•	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$\frac{i k (t_1 - 2 t_2)}{3 \sqrt{2}}$	0	0	0	0	$\sigma_{2^+}^{\!\!\!\!+1}$ †	.αβ	$\frac{\sigma_2^{\sharp}}{(1+2)}$	$\frac{t^{2}}{t^{2}} \alpha \beta$ $\frac{2}{k^{2}} (2)^{2}$			$\frac{1}{\alpha\beta}$ $\frac{\sqrt{2} k}{(k^2)^2 t}$		$\sigma_2^{\#1}_{\alpha\beta}$
9	$\mathcal{A}_1^{\#2} + \alpha \beta$	$f_1^{#1} + \alpha \beta$	$\mathcal{A}_1^{\sharp_1} +^{lpha}$	$\mathcal{A}_1^{\#2} +^{\alpha}$	$f_{1}^{\#1} + ^{lpha}$	$f_1^{\#2} + \alpha$	$ au_{2^{+}}^{\#1}\dagger \ \sigma_{2^{-}}^{\#1}\dagger^{c}$	_	2 i (1+2	$\frac{\sqrt{2} k}{k^2)^2}$		4 (1+2	$\frac{k^2}{(k^2)^2 t_1}$		$\frac{2}{t_1}$
							_	L							τI

 $f_{2+}^{\#1}\dagger^{\alpha\beta}$

Massive and massless spectra



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

Unitarity conditions

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