Particle spectrograph

Wave operator and propagator

SO(3) irreps	Fundamental fields	Multiplicities
$\sigma_0^{\#1} == 0$	$\epsilon \eta_{\alpha\beta\chi\delta} \partial^{\delta} \sigma^{\alpha\beta\chi} == 0$	1
$\tau_{0^{+}}^{\#2} == 0$	$\partial_{\beta}\partial_{\alpha}\tau^{\alpha\beta} == 0$	1
$\tau_{0+}^{\#1} - 2 \bar{i} k \sigma_{0+}^{\#1} == 0$	$\partial_{\beta}\partial_{\alpha}\tau^{\alpha\beta} = \partial_{\beta}\partial^{\beta}\tau^{\alpha}_{\alpha} + 2\partial_{\chi}\partial^{\chi}\partial_{\beta}\sigma^{\alpha\beta}_{\alpha}$	1
$\tau_{1-}^{\#2\alpha} + 2 i k \sigma_{1-}^{\#2\alpha} == 0$	$\partial_{\chi}\partial_{\beta}\partial^{\alpha}\tau^{\beta\chi} = \partial_{\chi}\partial^{\chi}\partial_{\beta}\tau^{\alpha\beta} + 2\partial_{\delta}\partial^{\delta}\partial_{\chi}\partial_{\beta}\sigma^{\alpha\beta\chi}$	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
$\tau_{1}^{\#1}{}^{\alpha\beta} == 0$	$\partial_{\chi}\partial^{\alpha}\tau^{\beta\chi} + \partial_{\chi}\partial^{\beta}\tau^{\chi\alpha} + \partial_{\chi}\partial^{\chi}\tau^{\alpha\beta} = =$	3
	$\partial_{\chi}\partial^{\alpha}\tau^{\chi\beta} + \partial_{\chi}\partial^{\beta}\tau^{\alpha\chi} + \partial_{\chi}\partial^{\chi}\tau^{\beta\alpha}$	
$\sigma_{1+}^{\#2\alpha\beta} == 0$	$\partial_{\delta}\partial_{\chi}\partial^{\alpha}\sigma^{\beta\chi\delta} + \partial_{\delta}\partial^{\delta}\partial_{\chi}\sigma^{\alpha\beta\chi} = \partial_{\delta}\partial_{\chi}\partial^{\beta}\sigma^{\alpha\chi\delta}$	3
$\tau_{2^{+}}^{\#1\alpha\beta} == 0$	$4 \partial_{\delta} \partial_{\chi} \partial^{\beta} \partial^{\alpha} \tau^{\chi \delta} + 2 \partial_{\delta} \partial^{\delta} \partial^{\beta} \partial^{\alpha} \tau^{\chi}_{\chi} +$	5
	$3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\chi} \tau^{\alpha\beta} + 3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\chi} \tau^{\beta\alpha} +$	
	$2 \eta^{\alpha\beta} \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial_{\chi} \tau^{\chi\delta} = 3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\alpha} \tau^{\beta\chi} +$	
	$3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\alpha} \tau^{\chi\beta} + 3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\beta} \tau^{\alpha\chi} +$	
	$3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\beta} \tau^{\chi \alpha} + 2 \eta^{\alpha \beta} \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \partial^{\delta} \tau^{\chi}_{\chi}$	
$\sigma_{2^{+}}^{\#1\alpha\beta} == 0$	$3 \partial_{\delta} \partial_{\chi} \partial^{\alpha} \sigma^{\beta \chi \delta} + 3 \partial_{\delta} \partial_{\chi} \partial^{\beta} \sigma^{\alpha \chi \delta} +$	5
	$2 \eta^{\alpha\beta} \partial_{\epsilon} \partial^{\epsilon} \partial_{\delta} \sigma^{\chi\delta}_{\chi} = 2 \partial_{\delta} \partial^{\beta} \partial^{\alpha} \sigma^{\chi\delta}_{\chi} +$	
	$3 \left(\partial_{\delta} \partial^{\delta} \partial_{\chi} \sigma^{\alpha \chi \beta} + \partial_{\delta} \partial^{\delta} \partial_{\chi} \sigma^{\beta \chi \alpha} \right)$	
 Total constraints/gai	uge generators:	25

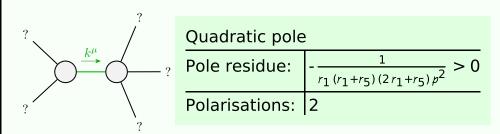
$\sigma_{1}^{\#1}{}_{lphaeta}$	$\sigma_{1}^{\#2}{}_{lphaeta}$ $\tau_{1}^{\#1}{}_{lphaeta}$	$\tau_1^{\#1}{}_+\alpha\beta$	$\sigma_{1^{-}\alpha}^{\#1}$	$\sigma_{1^-}^{\#2}{}_{\alpha}$	$\tau_{1^{-}}^{\#1}\alpha$	$\tau_{1}^{\#2}{}_{\alpha}$
$\sigma_{1}^{\#1} + \alpha \beta \left(\frac{1}{k^2 (2 r_1 + r_5)} \right)$	0	0	0	0	0	0
$\sigma_1^{\#2} + \alpha \beta = 0$	0	0	0	0	0	0
0	0	0	0	0	0	0
$\sigma_{1}^{\#1} +^{\alpha}$ 0	0	0	$\frac{1}{k^2 \left(r_1 + r_5\right)}$	$\frac{\sqrt{2}}{k^2 (1+2 k^2) (r_1+r_5)}$	0	$\frac{2i}{k(1+2k^2)(r_1+r_5)}$
$\sigma_{1}^{\#2} +^{\alpha}$ 0	0	0	$\frac{\sqrt{2}}{k^2 (1+2 k^2) (r_1 + r_5)}$	$\frac{3k^2(r_1+r_5)+2t_3}{(k+2k^3)^2(r_1+r_5)t_3}$	0	$i \sqrt{2} (3k^2 (r_1 + r_5) + 2t_3) / (t_1 + 2k^2)^2 (r_1 + r_5) t_3$
$t_1^{\#1} +^{\alpha}$ 0	0	0	0	0	0	0
$t_1^{\#2} + \alpha = 0$	0	0	$-\frac{2i}{k(1+2k^2)(r_1+r_5)}$	$-\frac{i\sqrt{2}(3k^2(r_1+r_5)+2t_3)}{k(1+2k^2)^2(r_1+r_5)t_3}$	0	$\frac{6k^2(r_1+r_5)+4t_3}{(1+2k^2)^2(r_1+r_5)t_3}$

$^{\prime}1^{-}$	>	>	>	k(1+2k	2) $(r_{1}+r_{5})$	(1^{-}) 0 0 $(1+2k^2)(r_1+r_5)$ $(1+2k^2)^2(r_1+r_5)t_3$		>	$(1+2k^2)^2 (r_1+r_5)$	+75)
(7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7									
Quadi ∨	Quadratic (rree) action	action								
	$\int (rac{1}{3} \left(-2 t_3 \mathcal{A} ight)$	$(^{lpha'}_{\ lpha} _{lpha}^{\ eta})$	9+3	$f^{lphaeta}$ $ au_{lphaeta}$	+ 3 A ^{aβ}	$\iiint \left(\frac{1}{3} \left(-2 t_3 \mathcal{A}^{\alpha \prime}_{\ \alpha} \mathcal{A}^{ \theta}_{\ \beta} + 3 f^{\alpha \beta} \tau_{\alpha \beta} + 3 \mathcal{A}^{\alpha \beta \chi} \sigma_{\alpha \beta \chi} + 4 t_3 \mathcal{A}^{ \theta}_{\ \alpha \ \beta} \partial_{\beta} f^{\alpha \prime} - 4 t_3 \right)$, θ θ, α,	f ^{αι}	4 <i>t</i> 3	
			$\mathcal{A}^{ heta}_{, heta}$	$\partial' f^{\alpha} +$	$2t_3\partial_i f^{\theta}$	$\mathcal{A}^{\theta}_{,\theta} \partial' f^{\alpha}_{\alpha} + 2 t_3 \partial_i f^{\theta}_{\theta} \partial' f^{\alpha}_{\alpha} + 2 t_3 \partial_i f^{\alpha\prime} \partial_{\theta} f^{\theta}_{\alpha} -$	$^{;lpha_{l}}$ و $^{artheta_{l}}$, θ,		
		4	t3 0'f	$^{\alpha}_{}\partial_{\theta}f_{}^{\theta}$	$-4r_1\partial_{eta}\mathcal{R}$	$4t_3\partial'f^{lpha}_{}\partial_{eta}f^{}_{}-4r_1\partial_{eta}\mathcal{A}_{lphaert}\partial^{eta}\mathcal{A}_{lpha}$	$r_1\partial_eta \mathcal{F}$	$(\alpha\theta)$		
			$\partial^{ heta}\mathcal{H}^{0}$	$^{(\beta)}$ - $8 r_1 c$	$\partial_{eta}\mathcal{A}_{etaeta}\partial^{ heta}$	$\partial^{\theta}\mathcal{A}^{lphaeta_{l}}$ - $8r_{1}\partial_{eta}\mathcal{A}_{\primeeta_{lpha}}\partial^{ heta}\mathcal{A}^{lphaeta_{l}}$ - $2r_{1}\partial_{\prime}\mathcal{A}_{lphaeta_{ heta}}\partial^{ heta}\mathcal{A}^{lphaeta_{l}}$ +	$\mathcal{E}^{\theta} \mathcal{E}_{\theta}$	$\mathcal{A}^{\alpha\beta\prime}$	+	
		2	$r_1 \partial_{\theta} S$	$\mathfrak{q}_{lphaeta_{l}}\partial^{ heta}\mathcal{F}_{l}$	$4^{\alpha\beta l} + 2 r_1$	$2r_1\partial_\theta\mathcal{R}_{\alpha\beta}\partial^\theta\mathcal{R}^{\alpha\beta'}+2r_1\partial_\theta\mathcal{R}_{\alpha\prime\beta}\partial^\theta\mathcal{R}^{\alpha\beta'}+$	_+			
		M	150,3	$\mathcal{E}_{\theta}\mathcal{E}_{\kappa}^{\theta}\mathcal{F}_{\theta}$	$t^{\alpha\prime}_{\alpha}$ -3 r_5	$3r_5\partial_i\mathcal{R}^{k}_{k}\partial^\theta\mathcal{R}^{\alpha\prime}_{a} - 3r_5\partial_\theta\mathcal{R}^{k}_{k}\partial^\theta\mathcal{R}^{\alpha\prime}_{a} - 3r_5\partial_\alpha\mathcal{R}^{\alpha\prime\theta}$.3 r ₅ 0	$^{lpha}\mathcal{H}^{lpha}$	θ	
			$\partial_{\kappa}\mathcal{A}_{1}$	$^{\kappa}_{\theta} + 6 r_{5}$	$\partial^{\theta}\mathcal{A}^{\alpha\prime}{}_{\alpha}\partial_{\alpha}$	$\partial_{\kappa}\mathcal{A}_{\beta}^{\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ $	$\mathcal{A}^{\alpha l \theta} \partial$	\mathcal{R}_{θ}		
		9	1 r5 00 3	$q^{\alpha l}_{\alpha}\partial_{\kappa}\mathcal{F}$	$q_{\theta^{(1)}})[t, x]$	$6r_5\partial^{ heta}\mathcal{R}^{lpha_{\prime}}_{lpha}\partial_{\kappa}\mathcal{R}^{}_{eta^{}}))[t,lpha,lpha,lpha_{\prime}]$ dz dy d $lpha$ dt	x dt			
	${\mathcal A}_{1+\alpha\beta}^{\#1}$	$\mathcal{A}_{1+lphaeta}^{\#1}$ $\mathcal{A}_{1+lphaeta}^{\#2}$ $f_{1+lphaeta}^{\#1}$	$f^{2}_{\alpha\beta} f^{\#}_{1}$	$^{1}_{+}$	${\mathscr A}_{1^-}^{\#1}{}_{\alpha}$	$\mathcal{A}_{1^-}^{\#2}$ $f_{1^-}^{\#1}$ $f_{1^-}^{\#2}$	$f_1^{\#1}$	σ	$f_{1^-}^{\#2}$	

$f_{1^-}^{\#^2} \alpha$	0	0	0	$-\frac{2}{3}ikt_3$	$\frac{1}{3}\bar{l}\sqrt{2}kt_3$	0	$\frac{2k^2t_3}{3}$	
$f_{1^-}^{\#_1} \alpha$	0	0	0	0	0	0	0	
${\mathcal A}_{1^-}^{\#^2}$	0	0	0	$-\frac{\sqrt{2} t_3}{3}$	ε Ε 3	0	$-\frac{1}{3}\bar{l}\sqrt{2}kt_3$	
$\mathcal{A}_{1^{-}}^{\#^{1}}\alpha$	0	0	0	$k^2 (r_1 + r_5) + \frac{2t_3}{3}$	$-\frac{\sqrt{2}t_3}{3}$	0	<u>2 i k t 3</u> 3	Я#
$f_{1}^{\#_{1}} \alpha \beta$	0	0	0	0	0	0	0	$\mathcal{F}_2^{\#}$
$\mathcal{A}_1^{\#} ^{\dagger} \alpha_{eta} f_1^{\#} ^{\dagger} \alpha_{eta}$	0	0	0	0	0	0	0	$\mathcal{A}_2^{\#1}$
${\mathscr A}_1^{\#^+_+}\alpha\beta$	$k^2 (2 r_1 + r_5)$	0	0	0	0	0	0	$\sigma_{0^{+}}^{\#1}$ $ au_{0^{+}}^{\#1}$
	$\mathcal{A}_{1}^{\#1} + \alpha^{\beta}$	$\mathcal{A}_{1}^{\#2} + \alpha^{\beta}$	$f_{1+}^{#1} + ^{\alpha \beta}$	$\mathcal{A}_{1}^{\#1} +^{\alpha}$	$\mathcal{A}_{1}^{\#2} \dagger^{lpha}$	$f_{1^{\bar{-}}}^{\#1} +^{\alpha}$	$f_1^{#2} +^{\alpha}$	$ au_{0^{+}}^{\#2}$ $\sigma_{0^{-}}^{\#1}$

						~						
						$\sigma_{2^{-}}^{\#1} lpha eta \chi$	0	0	1 2	k- r ₁		
						$\tau_{2}^{\#1}$	0	0	0	,		
						$\sigma_{2}^{\#1}$	0	0	0			
		$\mathcal{A}_{2}^{\#1}{}_{lphaeta}$	$f_{2}^{\#1}_{\alpha\beta}$	$\mathcal{A}_2^{\#_2^1}$	l αβχ		$\sigma_{2}^{\#1} + \alpha \beta$	$\tau_2^{\#1} + \alpha\beta$	$\sigma_{2}^{#1} + \alpha \beta \chi$	- -		
(#1 ·	$\dagger^{\alpha\beta}$	0	0	()		ı		Ğ	•		
-#1. 2 ⁺	$\dagger^{\alpha\beta}$	0	0	()		$\mathcal{A}_{0^{\text{-}}}^{\#1}$	0	0	0	0	
^{#1} †	αβχ	0	0	k ²	r_1		$f_{0}^{\#2}$	0	0	0	0	
Ī		$\sigma_{0}^{\sharp 1}$	$ au_{0}^{\#1}$		$ au_{0}^{\#2}$	$\sigma_0^{\#1}$	$f_{0}^{\#1}$	$i\sqrt{2} kt_3$	$2 k^2 t_3$	0	0	
1 + †	(1+	$\frac{1}{2k^2)^2t_3}$	$-\frac{i\sqrt{2}k}{(1+2k^2)^2t_3}$		0	0	f	- <u>ı̃</u> √				
1 †		$\frac{\sqrt{2} k}{2 k^2)^2 t_3}$	$\frac{2k^2}{(1+2k^2)^2t_3}$		0	0	$\mathcal{A}_{0}^{\#1}$	t_3	$\bar{I}\sqrt{2}~kt_3$	0	0	
² †		0	0		0	0		+	+	+	+	
¹ †		0	0		0	0		$\mathcal{A}_{0}^{\#1}$	$f_{0}^{\#1}$	$f_0^{\#2}$ †	$\mathcal{A}_{0}^{\#1}$ \dagger	

Massive and massless spectra



(No massive particles)

Unitarity conditions

$$r_1 < 0 \&\& (r_5 < -r_1 || r_5 > -2 r_1) || r_1 > 0 \&\& -2 r_1 < r_5 < -r_1$$