## Particle spectrograph

## Wave operator and propagator

				Ιm				
$\tau_{1}^{\#2}{}_{\alpha}$	0	0	0	$-\frac{6ik}{(3+2k^2)^2t_3}$	$\frac{3 i \sqrt{2} k}{(3+2 k^2)^2 t_3}$	0	$\frac{6k^2}{(3+2k^2)^2t_3}$	
$\tau_{1}^{\#1}{}_{\alpha}$	0	0	0	0	0	0	0	
$\sigma_{1}^{\#2}{}_{\alpha}$	0	0	0	$-\frac{3\sqrt{2}}{(3+2k^2)^2t_3}$	$\frac{3}{(3+2k^2)^2t_3}$	0	$-\frac{3i\sqrt{2}k}{(3+2k^2)^2t_3}$	
$\sigma_{1^-}^{\#1}{}_{\alpha}$	0	0	0	$\frac{6}{(3+2 k^2)^2 t_3}$	$-\frac{3\sqrt{2}}{(3+2k^2)^2t_3}$	0	$\frac{6ik}{(3+2k^2)^2t_3}$	
$\tau_{1}^{\#1}_{+}$	$-\frac{2i\sqrt{2}}{3kr_3+3k^3r_3}$	$\frac{i(9k^2r_3+4t_2)}{3k(1+k^2)^2r_3t_2}$	$\frac{9k^2r_3+4t_2}{3(1+k^2)^2r_3t_2}$	0	0	0	0	
$\sigma_{1}^{\#2}{}_{+}\alpha\beta$	$-\frac{2\sqrt{2}}{3k^2r_3+3k^4r_3}$	$\frac{9k^2r_3+4t_2}{3(k+k^3)^2r_3t_2}$	$-\frac{i(9k^2r_3+4t_2)}{3k(1+k^2)^2r_3t_2}$	0	0	0	0	
$\sigma_{1}^{\#1}{}_{\alpha\beta}$	$\frac{2}{3k^2r_3}$	$\frac{2\sqrt{2}}{3k^2r_3+3k^4r_3}$	$\frac{2i\sqrt{2}}{3kr_3+3k^3r_3}$	0	0	0	0	
	$\sigma_{1}^{\#1} + \alpha \beta$	$\sigma_{1}^{#2} + \alpha^{\beta}$	$t_1^{\#1} + \alpha \beta$	$\sigma_{1}^{\#1} +^{lpha}$	$\sigma_{1}^{\#2} + ^{\alpha}$	$\tau_1^{\#_1} +^\alpha$	$\tau_{1}^{\#2} + \alpha$	

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$f_{1^-}^{\#^2} \alpha$	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
$\omega_{1^{^{-}}\alpha}^{\#^{2}}$	0	0	0	$-\frac{\sqrt{2}t_3}{3}$	<u>t3</u> 3	0	$-\frac{1}{3}i\sqrt{2}kt_3$
$\omega_{1^{-}\alpha}^{\#_{1}}$	0	0	0	$\frac{2t_3}{3}$	$-\frac{\sqrt{2}t_3}{3}$	0	<u>2 i kt3</u> 3
$f_1^{\#_1} \alpha \beta$	$\frac{1}{3}\bar{l}\sqrt{2}kt_2$	<u>i kt2</u> 3	$\frac{k^2 t_2}{3}$	0	0	0	0
$\omega_1^{\#}{}^{\!$	$\frac{\sqrt{2} t_2}{3}$	4 <u>7</u>	$-\frac{1}{3}$ i k t <sub>2</sub>	0	0	0	0
$\omega_1^{*+}{}_+^{1}$	$\frac{1}{6} (9 k^2 r_3 + 4 t_2)$	$\frac{\sqrt{2} t_2}{3}$	$-\frac{1}{3}$ i $\sqrt{2}$ kt <sub>2</sub>	0	0	0	0
'	$\omega_1^{#1} + \alpha \beta$	$\omega_1^{\#2} + \alpha \beta$	$f_{1}^{\#1} + \alpha \beta$	$\omega_{1}^{\#1} +^{\alpha}$	$\omega_1^{\#2} +^{lpha}$	$f_{1^{\bar{-}}}^{\#1} \dagger^{\alpha}$	$f_1^{\#2} + \alpha$

Quadratic (free) action	$S == \begin{cases} \int \int \int \int_{\alpha}^{1} (-4t_{3} \ \omega^{\alpha_{i}} \ \omega^{\kappa}_{i} + 6 \ f^{\alpha\beta} \ t_{\alpha\beta} + 6 \ \omega^{\alpha\beta\chi} \ \sigma_{\alpha\beta\chi} + 8t_{3} \ \omega^{\kappa}_{i} \ \partial_{i} f^{\alpha_{i}} - 8t_{3} \ \omega^{\kappa}_{i} \ \partial_{i} f^{\alpha_{i}} - 8t_{3} \ \omega^{\kappa}_{i} \ \partial_{i} f^{\alpha_{i}} - 8t_{3} \ \omega^{\kappa}_{i} \ \partial_{i} f^{\alpha_{i}} + 4t_{3} \partial_{i} f^{\kappa}_{i} \partial_{i} f^{\alpha_{i}} - 6r_{3} \partial_{i} \omega^{\alpha\beta} \partial_{i} \partial$
Quadr	$S == \int \int \int \int \int \int \frac{1}{6} dt$ $12 r_3 t_2$ $2 t_2 u$ $2 t_2 u$ $3 \mu \mu_{19}$ $4 r_2 \partial_{\theta}$

	<b>5</b>					J				3 + + 3					
nerators	Multiplicities										$\sigma_{0^{\text{-}}}^{\#1}$	0	0	0	$\frac{1}{k^2 r_2 + t_2}$
ger	iplic										$\tau_0^{\#2}$	0	0	0	0
Source constraints/gauge generators	Mult	1	0 1	== 0 3	Ж	== 0 3	$\alpha\beta$ == 0 3	2	2	its: 24	$\tau_0^{\#1}$	$-\frac{i\sqrt{2}k}{(1+2k^2)^2t_3}$	$\frac{2k^2}{(1+2k^2)^2t_3}$	0	0
ce constra	SO(3) irreps	0 ==	2 i k	-īk $\sigma_{1}^{\#1}{}^{lpha}$	0 ==	+20	<u> </u>		θ1 == 0	Total constraints:	$\sigma_{0^+}^{\#1}$	$\frac{1}{(1+2k^2)^2t_3}$	$\frac{i\sqrt{2}k}{(1+2k^2)^2t_3}$	0	0
Sour	SO(3	$\tau_{0}^{\#2} =$	$\tau_{0}^{\#1}$ -	$t_1^{\#2}\alpha$	$ au_1^{\#1lpha}$	$\sigma_{1}^{\#1}{}^{\alpha}$	$\tau_1^{\#1}\alpha\beta$	$\sigma_2^{\#1}{}^{\alpha\beta\chi}$	$\tau_2^{\#1}\alpha\beta$	Tota		$\sigma_{0}^{\#1}$ †	$\tau_{0}^{\#1}$ †	$\tau_{0}^{\#2}$ †	$\sigma_{0^-}^{\#1} \dagger$

0

0

0

0

0

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

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

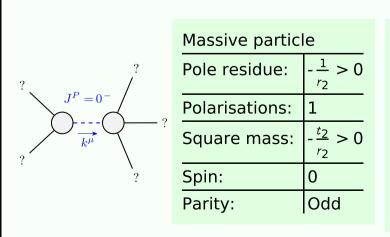
 $\omega_{0}^{\#1}$ 

 $\sqrt{2} kt_3$ 

0

 $f_{0}^{#1} + f_{0}^{#2} + f_{0}^{#2} + \omega_{0}^{#1} + f_{0}^{#2}$ 

## Massive and massless spectra



(No massless particles)

Unitarity conditions

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