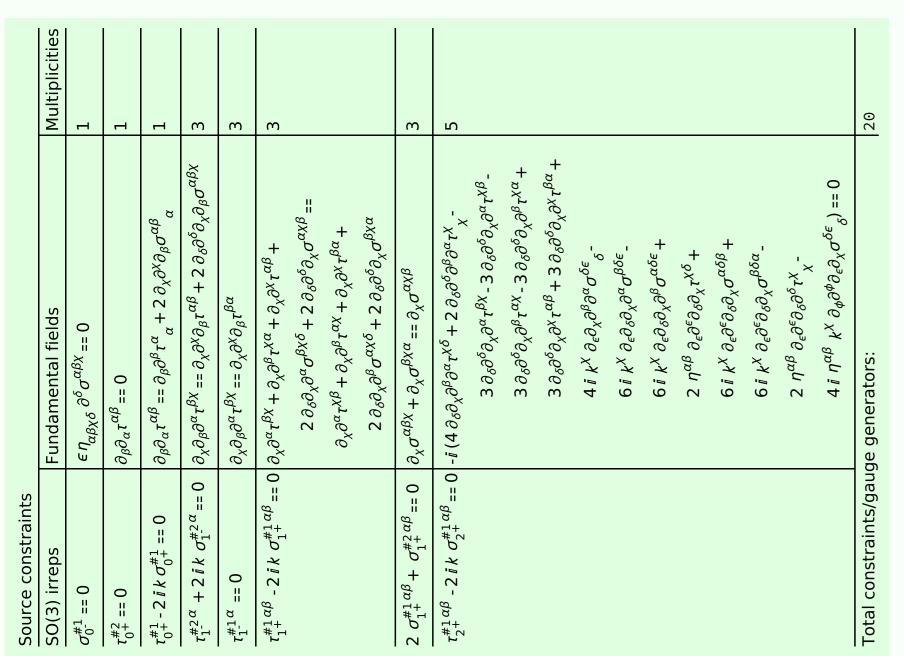
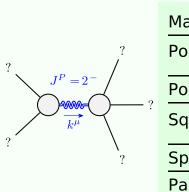
Particle spectrograph

Wave operator and propagator



Quadratic (free) action	$S == \iiint (\frac{1}{3} (3t_1 \ \omega^{\alpha \prime} \ \omega^{\theta}_{\prime \ \theta} + 3 \ f^{\alpha \beta} \ \tau_{\alpha \beta} + 3 \ \omega^{\alpha \beta \chi} \ \sigma_{\alpha \beta \chi} - 6 \ t_1 \ \omega^{\theta}_{\alpha \ \theta} \ \partial_{\prime} f^{\alpha \prime} +$	$6t_1\omega_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_$	$6r_1\partial_{,}\omega_{\beta}^{\ \theta}\partial^{\prime}\omega^{\alpha\beta}_{\ \alpha}-3t_1\partial_{,}f^{\alpha\prime}\partial_{\theta}f_{\ \alpha}^{\ \theta}+6t_1\partial^{\prime}f^{\alpha}_{\ \alpha}\partial_{\theta}f_{\ \beta}^{\ \theta}+$	$6r_1\partial_\alpha\omega^{\alpha\beta'}\partial_\theta\omega^{\ \theta}_{\beta\ '}\text{-}12r_1\partial'\omega^{\alpha\beta}_{\ \alpha}\partial_\theta\omega^{\ \theta}_{\beta\ '}\text{-}$	$6r_1\partial_\alpha\omega^{\alpha\beta'}\partial_\theta\omega'^{\;\theta}_{\;\;\beta} + 12r_1\partial'\omega^{\alpha\beta}_{\;\;\alpha}\partial_\theta\omega'^{\;\theta}_{\;\;\beta} +$	$2t_1\omega_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_{_$	$t_1 \partial_{\scriptscriptstyle } f_{\alpha \theta} \partial^{\theta} f^{\alpha \prime} + 2 t_1 \partial_{\theta} f_{\alpha \prime} \partial^{\theta} f^{\alpha \prime} + t_1 \partial_{\theta} f_{ \prime \alpha} \partial^{\theta} f^{\alpha \prime} +$	$t_1 \; \omega_{lpha eta} \; (\; \omega^{lpha eta} \; + \; 2 \; \partial^{ heta} f^{lpha eta}) + t_1 \; \omega_{lpha eta} \; (\; \omega^{lpha eta} \; + \; 4 \; \partial^{ heta} f^{lpha eta}) -$	$4r_1\partial_\beta\omega_{\alpha\prime\theta}\partial^\theta\omega^{\alpha\beta\prime} + 2r_1\partial_\beta\omega_{\alpha\theta\prime}\partial^\theta\omega^{\alpha\beta\prime} - 8r_1\partial_\beta\omega_{\prime\theta\alpha}$	$\partial^{\theta}\omega^{\alpha\beta'}$ - $2r_1\partial_{,}\omega_{\alpha\beta\theta}\partial^{\theta}\omega^{\alpha\beta'}$ + $2r_1\partial_{\theta}\omega_{\alpha\beta'}\partial^{\theta}\omega^{\alpha\beta'}$ +	$2r_1\partial_ heta\omega_{lphaetaeta}\partial^ heta\omega^{lphaeta_1}))[t,ec{ec{\kappa}},ec{ec{ec{ec{\kappa}}}},ec{ec{ec{ec{ec{\kappa}}}}}]dzdydec{ec{ec{ec{ec{ec{\kappa}}}}}}$
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	<u> </u>	ρ _# Ի _Ω	#P .P. .P.	1.5
Ma	assive	and	massless	spectra



	Massive partic	le	
?	Pole residue:	$\left -\frac{1}{r_1} > 0 \right $	=
$J^P = 2^-$	Polarisations:	5	ildssiess
?	Square mass:	$-\frac{t_1}{2r_1} > 0$	_
?	Spin:	2	particles
	Parity:	Odd	(Say)

Unitarity conditions

α				$\frac{c}{2t_1}$	$\frac{2}{t_1}$		$\frac{r_1+t_1)}{t_1)^2}$										_						
$t_1^{\#^2} \alpha$	0	0	0	$\frac{2ik}{t_1 + 2k^2t_1}$	$\frac{i\sqrt{2}}{(t_1 + 2k^2t_1)^2}$	0	$\frac{2k^2(2k^2r_1+t_1)}{(t_1+2k^2t_1)^2}$	$\sigma_{0}^{\#1}$	0	0	0	0	$\sigma_{2^{-}}^{\#1} \alpha eta \chi$	0	0	$\frac{2}{2k^2r_1+t_1}$							
$ au_{1^{-1}}^{\#_1} lpha$	0	0	0	0	0	0	0	$\tau_{0}^{\#2}$	0	1 0	0	0	-	$\frac{k}{2t_1}$	2 t ₁	7.7							
$\sigma_{1}^{\#2}$	0	0	0	$\frac{\sqrt{2}}{t_1 + 2k^2t_1}$	$\frac{2 k^2 r_1 + t_1}{(t_1 + 2 k^2 t_1)^2}$	0	$\frac{i\sqrt{2}}{(t_1+2k^2t_1)^2}$	${\tau_0^\#}_+^1$	$\frac{i\sqrt{2}k}{(1+2k^2)^2t_1}$	$-\frac{2k^2}{(1+2k^2)^2t_1}$	0	0	_	(1+	$\begin{vmatrix} 4 & k^2 \\ 1 & (1+2 & k^2)^2 & t_1 \end{vmatrix}$	0							
ρ				t ₁ +	$\frac{2k^2}{(t_1+2)}$		$-\frac{i\sqrt{2}k(1+t)}{(t_1+t)}$	$\sigma_{0}^{\#1}$	$\frac{1}{(1+2k^2)^2t_1}$	$\frac{i\sqrt{2}k}{(1+2k^2)^2t_1}$	0	0	$\sigma_{2}^{\#1}{}_{\alpha\beta}$	$\frac{2}{(1+2k^2)^2t_1}$	$\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$	0							
$\sigma_{1^{-}\alpha}^{\#_{1}}$	0	0	0	0	$\frac{\sqrt{2}}{t_1 + 2k^2t_1}$	0	$\frac{2ik}{t_1+2k^2t_1}$	0	J	ı			L	$\sigma_2^{#1} + \alpha \beta$ (1)	$\tau_2^{\#1} + \alpha \beta \boxed{{(1)}}$	$\sigma_{2^{-}}^{*1} +^{\alpha \beta \chi}$	J		<u>t</u> 1 2		$\frac{kt_1}{\sqrt{2}}$	C)
٦					t ₁ +				$\sigma_{0}^{\#1}$ †	$\tau_{0}^{\#1}$ †	$\tau_{0}^{#2} +$	$\sigma_{0}^{\#1}$ \dagger		$\sigma_{2}^{\#1}$	$\tau_2^{\#1}$	$\sigma_2^{\#1}$			$\frac{i kt}{\sqrt{2}}$	$\frac{1}{5} k^2$	$^{2}t_{1}$	C)
	1 -		_						_			_							· ·				
$+\alpha\beta$	$\frac{7\sqrt{2} k}{2k^2)^2 t_1}$	$\frac{2ik}{k^2)^2t_1}$	$\frac{2k^2}{k^2)^2t_1}$	0	0	0	0			$\omega_{1}^{\#1}{}_{lphaeta}$			$f_{1}^{\#1}_{\alpha\beta}$	$\omega_1^{\scriptscriptstyle\#}$	-1 α		$f_{1-\alpha}^{\#1}$	$f_{1}^{#2}\alpha$	0		0	$k^2 r_1$	$+\frac{t_1}{2}$
$\tau_1^{"+}\alpha\beta$	$-\frac{6\bar{\imath}\sqrt{2}k}{(3+2k^2)^2t_1}$	$\frac{12ik}{(3+2k^2)^2t_1}$	$\frac{12k^2}{(3+2k^2)^2t_1}$	0	0	0	0	$\omega_{1}^{\#1}$		$\omega_{1}^{\#1}_{\alpha\beta}$ $\frac{t_{1}}{6}$		<i>αβ</i>	$f_{1+\alpha\beta}^{\#1}$ $-\frac{ikt_1}{3\sqrt{2}}$	ω ₁ ,			$f_{1}^{#1}_{\alpha}$	$f_{1}^{#2}\alpha$	0		0	$k^2 r_1$	$+\frac{t_1}{2}$
	i										$\omega_{1}^{\#2}$	αβ L /2	$-\frac{ikt_1}{3\sqrt{2}}$)	$\omega_{1}^{\#2}{}_{\alpha}$			$\omega_{0}^{\#1}$ 0				
$\sigma_1^{"+} = \alpha_\beta \qquad \tau_1^{"+} = \alpha_\beta$	$-\frac{6\sqrt{2}}{(3+2k^2)^2t_1} - \frac{6i\sqrt{2}k}{(3+2k^2)^2t_1}$	$\frac{12}{(3+2k^2)^2t_1}$	$-\frac{12ik}{(3+2k^2)^2t_1} \frac{12k^2}{(3+2k^2)^2t_1}$	0 0	0 0	0 0	0 0	$\omega_{1}^{\#2}$	$\pm \dagger^{lphaeta}$	<u>t</u> 1 6	$\omega_1^{\#2}$ $-\frac{t_1}{3\sqrt{1}}$	αβ <u>L</u> /2	īkt ₁	С)	$\omega_{1-\alpha}^{\#2}$	0	0	$f_{0}^{\#2} \omega_{0}^{\#1}$ 0	kt_1 0 0	0	0 0	0
$\sigma_1^{*+} \alpha_{eta}$	$-\frac{6\sqrt{2}}{(3+2k^2)^2t_1} - \frac{6\sqrt{2}}{t_1}$	$\frac{12}{(3+2k^2)^2t_1}$	$-\frac{12ik}{(3+2k^2)^2t_1}$	0	0	0	0	$\omega_{1}^{\#_{1}^{2}}$ $f_{1}^{\#_{1}^{1}}$	$\frac{1}{2} + \frac{\alpha \beta}{\alpha \beta}$	$\frac{t_1}{6}$ $-\frac{t_1}{3\sqrt{2}}$	$\omega_{1}^{\#2}$ $-\frac{t_{1}}{3\sqrt{\frac{t_{1}}{3\sqrt{\frac{t_{1}}{3}}}}}$	$\alpha \beta$ $\frac{1}{\sqrt{2}}$ kt_1	$-\frac{i k t_1}{3 \sqrt{2}}$ $\frac{i k t_1}{3}$	C))	ω ₁ ^{#2} α 0 0	0	0	$\omega_{0}^{\#1}$ 0	0 0	$-2k^2t_1$ 0 0	0	0 0
$\sigma_1^{*+} \alpha_{eta}$	i	$\frac{12}{(3+2k^2)^2t_1}$						$\omega_{1}^{\#2}$ $f_{1}^{\#1}$ $\omega_{1}^{\#3}$	$\frac{1}{2} + \frac{\alpha \beta}{\alpha \beta}$	$\frac{t_1}{6}$ $-\frac{t_1}{3\sqrt{2}}$ $\frac{ikt_1}{3\sqrt{2}}$	$\omega_{1}^{\#2}$ $-\frac{t_{1}}{3}\sqrt{\frac{t_{1}}{3}}$ $-\frac{1}{3}\bar{i}k$	$\alpha \beta$ $\frac{1}{\sqrt{2}}$ kt_1	$-\frac{ikt_1}{3\sqrt{2}}$ $\frac{ikt_1}{3}$ $\frac{k^2t_1}{3}$	0))) 1 - $\frac{t_1}{2}$	$ \begin{array}{c c} \omega_{1}^{\#2}_{\alpha} \\ 0 \\ 0 \\ 0 \end{array} $	0 0 0	0 0 0	$f_{0}^{#1}$ $f_{0}^{#2}$ $\omega_{0}^{#1}$ 0	kt_1 0 0	$t_1 - 2k^2t_1 = 0$	0 0	0 0
$\sigma_1^{*+} \alpha_{eta}$	$\frac{6}{(3+2k^2)^2t_1} \left -\frac{6\sqrt{2}}{(3+2k^2)^2t_1} \right -$	$-\frac{6\sqrt{2}}{(3+2k^2)^2t_1} \frac{12}{(3+2k^2)^2t_1}$	$\frac{6i\sqrt{2}k}{(3+2k^2)^2t_1} - \frac{12ik}{(3+2k^2)^2t_1}$	0 0	0 0	0 0	0 0	$\omega_{1}^{\#2}$ $\omega_{1}^{\#3}$ $f_{1}^{\#1}$ $\omega_{1}^{\#}$ $\omega_{1}^{\#}$	$\frac{1}{2} + \frac{\alpha \beta}{\alpha \beta}$ $\frac{1}{2} + \frac{\alpha \beta}{\alpha \beta}$	$\frac{t_1}{6}$ $-\frac{t_1}{3\sqrt{2}}$ $\frac{ikt_1}{3\sqrt{2}}$ 0	$\omega_{1}^{\#2}$ $-\frac{t_{1}}{3}\sqrt{\frac{t_{1}}{3}}$ $-\frac{1}{3}ik$ 0	αβ 	$-\frac{ikt_1}{3\sqrt{2}}$ $\frac{ikt_1}{3}$ $\frac{k^2t_1}{3}$ 0	$-k^2 r_1$) $1 - \frac{t_1}{2}$ $\frac{1}{2}$	$\omega_{1}^{\#2}\alpha$ 0 0 $\frac{t_{1}}{\sqrt{2}}$	0 0 0 0	0 0 0 ikt ₁	$\omega_{0}^{\#1}$ $f_{0}^{\#1}$ $f_{0}^{\#2}$ $\omega_{0}^{\#1}$ $\omega_{0}^{\#1}$	$-t_1$ $i\sqrt{2}kt_1$ 0 0	$-i \sqrt{2} kt_1 - 2k^2 t_1 = 0$	0 0 0 0	0 0 0 0
$\sigma_1^{*+} \alpha_{eta}$	$-\frac{6\sqrt{2}}{(3+2k^2)^2t_1} - \frac{6\sqrt{2}}{t_1}$	$\frac{12}{(3+2k^2)^2t_1}$	$-\frac{12ik}{(3+2k^2)^2t_1}$	0	0	0	0	$\omega_{1}^{\#2}$ $\omega_{1}^{\#2}$ $f_{1}^{\#1}$ $\omega_{1}^{\#}$ $\omega_{1}^{\#}$ $f_{1}^{\#}$	$\begin{array}{c} +^{\alpha\beta} \\ +^{\alpha\beta} \\ +^{\alpha\beta} \\ \end{array}$	$\frac{t_1}{6}$ $-\frac{t_1}{3\sqrt{2}}$ $\frac{ikt_1}{3\sqrt{2}}$ 0	$\omega_{1}^{\#2}$ $-\frac{t_{1}}{3}\sqrt{\frac{t_{1}}{3}}$ $-\frac{1}{3}ik$ 0	αβ <u>L</u> /2 kt ₁	$-\frac{ikt_1}{3\sqrt{2}}$ $\frac{ikt_1}{3}$ $\frac{k^2t_1}{3}$ 0	$-k^2 r_1$) 1 - $\frac{t_1}{2}$ 1 - $\frac{t_2}{2}$ 1 - $\frac{t_3}{2}$	$\omega_{1}^{\#2}\alpha$ 0 0 $\frac{t_{1}}{\sqrt{2}}$ 0	0 0 0 0	0 0 0 ikt ₁	$\omega_{0}^{\#1}$ $f_{0}^{\#1}$ $f_{0}^{\#2}$ $\omega_{0}^{\#1}$ $\omega_{0}^{\#1}$	$i\sqrt{2}kt_1$ 0 0	$-i \sqrt{2} kt_1 - 2k^2 t_1 = 0$	0 0 0 0	0 0 0

 $r_1 < 0 \&\& t_1 > 0$