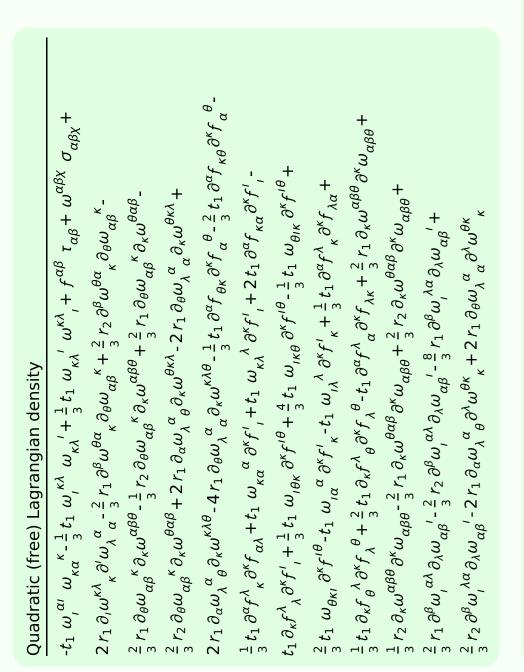
Particle spectrograph

Wave operator and propagator



$ au_1^{\#2}$	0	0	0	$\frac{2ik}{t_1 + 2k^2t_1}$	$\frac{i\sqrt{2}}{(t_1 + 2k^2t_1)^2}$	0	$\frac{2 k^2 (2 k^2 r_1 + t_1)}{(t_1 + 2 k^2 t_1)^2}$
$\tau_{1}^{\#1}{}_{\alpha}$	0	0	0	0	0	0	0
$\sigma_{1}^{\#2}{}_{lpha}$	0	0	0	$\frac{\sqrt{2}}{t_1 + 2 k^2 t_1}$	$\frac{2 k^2 r_1 + t_1}{(t_1 + 2 k^2 t_1)^2}$	0	$-\frac{i\sqrt{2}k(2k^2r_1+t_1)}{(t_1+2k^2t_1)^2}$
$\sigma_{1}^{\#1}{}_{\alpha}$	0	0	0	0	$\frac{\sqrt{2}}{t_1 + 2k^2t_1}$	0	$-\frac{2ik}{t_1+2k^2t_1}$
${\tau_1^{\#1}}^+_{\alpha\beta}$	$-\frac{6i\sqrt{2}k}{(3+2k^2)^2t_1}$	$\frac{12ik}{(3+2k^2)^2t_1}$	$\frac{12k^2}{(3+2k^2)^2t_1}$	0	0	0	0
$\sigma_1^{\#2}{}_+\alpha\beta$	$-\frac{6\sqrt{2}}{(3+2k^2)^2t_1}$	$\frac{12}{(3+2k^2)^2t_1}$	$-\frac{12ik}{(3+2k^2)^2t_1}$	0	0	0	0
$\sigma_{1}^{\#1}{}_{\!$	$\frac{6}{(3+2k^2)^2t_1}$	$-\frac{6\sqrt{2}}{(3+2k^2)^2t_1}$	$\frac{6i\sqrt{2}k}{(3+2k^2)^2t_1}$	0	0	0	0
	$\sigma_{1}^{\#1} + \alpha \beta$	$\sigma_{1}^{#2} + \alpha \beta$	$\tau_{1}^{#1} + \alpha \beta$	$\sigma_{1}^{\#_1} +^{\alpha}$	$\sigma_{1}^{\#2} +^{lpha}$	$\tau_{1}^{\#1} +^{\alpha}$	$\tau_1^{\#2} + \alpha$

	$\sigma_{0}^{\#1}$	$\tau_{0^{+}}^{\#1}$	$ au_{0}^{\#2}$	$\sigma_0^{\#1}$
$\sigma_{0^{+}}^{\#1}$ †	$-\frac{1}{(1+2k^2)^2t_1}$	$\frac{i\sqrt{2} k}{(1+2k^2)^2 t_1}$	0	0
$\tau_{0}^{\#1}$ †	$-\frac{i\sqrt{2} k}{(1+2k^2)^2 t_1}$	$-\frac{2k^2}{(1+2k^2)^2t_1}$	0	0
$\tau_{0}^{\#2}$ †	0	0	0	0
$\sigma_0^{\sharp 1}$ †	0	0	0	$\frac{1}{k^2 r_2}$

	$\sigma_{2^{+}\alpha\beta}^{\#1}$	$\tau_{2}^{\#1}{}_{\alpha\beta}$	$\sigma_2^{\sharp 1}{}_{\alpha\beta\chi}$
$\sigma_{2}^{\#1} \dagger^{\alpha\beta}$	$\frac{2}{(1+2k^2)^2t_1}$	$-\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$	0
$ au_{2}^{\#1} \dagger^{lphaeta}$	$\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$	$\frac{4k^2}{(1+2k^2)^2t_1}$	0
$\sigma_2^{#1} \dagger^{\alpha\beta\chi}$	0	0	$\frac{2}{2k^2r_1+t_1}$

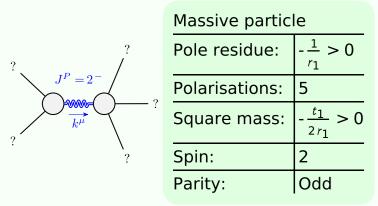
$f_{1}^{#2}$	0	0	0	$i k t_1$	0	0	0
$f_{1}^{\#1}$	0	0	0	0	0	0	0
$\omega_{1^{-}}^{\#2}{}_{lpha}$	0	0	0	$\frac{t_1}{\sqrt{2}}$	0	0	0
$\omega_{1}^{\#1}{}_{\alpha}$	0	0	0	$-k^2 r_1 - \frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	0	$-\bar{l}kt_1$
$f_{1}^{\#1}{}_{\!$	$-\frac{ikt_1}{3\sqrt{2}}$	<i>ikt</i> 133	$\frac{k^2 t_1}{3}$	0	0	0	0
$\omega_{1}^{\#2}{}_{\!\!\!\!/}^{}_{\!\!\!\!/}^{}$	$-\frac{t_1}{3\sqrt{2}}$	1 1 3	$-rac{1}{3}\bar{l}kt_1$	0	0	0	0
$\omega_{1}^{\#1}{}_{\alpha\beta}$	6 6	$-\frac{t_1}{3\sqrt{2}}$	$\frac{i k t_1}{3 \sqrt{2}}$	0	0	0	0
	$\omega_1^{\#1} + ^{lphaeta}$	$\omega_1^{\#2} + \alpha^{eta}$	$f_1^{\#1} + \alpha \beta$	$\omega_{1^{\bar{-}}}^{\#_1} +^{\alpha}$	$\omega_{1}^{\#2} +^{lpha}$	$f_{1}^{\#_1} +^{\alpha}$	$f_1^{\#2} +^{\alpha}$
	3	3					

$\omega_{2^{-}}^{\#1}{}_{\alpha\beta\chi}$	0	0	$k^2 r_1 + \frac{t_1}{2}$	
$f_{2}^{\#1}_{\alpha\beta}$	$-\frac{i k t_1}{\sqrt{2}}$	$k^2 t_1$	0	
$\omega_2^{\#1}_{+\alpha\beta} \ f_2^{\#1}_{+\alpha\beta}$	$\frac{t_1}{2}$	$\frac{ikt_1}{\sqrt{2}}$	0	
·	$\omega_2^{\#1} + ^{lphaeta}$	$f_2^{#1} + \alpha \beta$	$\omega_{2^{-}}^{\#1} +^{lphaeta\chi}$	

	$\omega_0^{\#1}$	$f_{0+}^{#1}$	$f_{0}^{#2}$	$\omega_0^{\#1}$
$\omega_{0}^{\#1}$ †	-t ₁	$i \sqrt{2} kt_1$	0	0
$f_{0}^{#1}$ †	$-i \sqrt{2} kt_1$	$-2 k^2 t_1$	0	0
$f_{0}^{#2}$ †	0	0	0	0
$\omega_{0}^{#1}$ †	0	0	0	$k^2 r_2$

Multiplicities	1	1	3	3	3	3	2	19
(O(3) irreps	# ² ₀ == 0	$_{0}^{#1} - 2 ik \sigma_{0}^{#1} = 0$	$\int_{1^{-1}}^{\#^{2}\alpha} + 2ik \sigma_{1^{-1}}^{\#^{2}\alpha} = 0$	$\int_{1^{-}}^{\#_{1}\alpha} = 0$	$\int_{1^{+}}^{\#_{1}} \alpha \beta - 2 i k O_{1^{+}}^{\#_{1}} \alpha \beta = 0 3$	$\sigma_{1+}^{\#1}\alpha\beta + \sigma_{1+}^{\#2}\alpha\beta == 0$	$\int_{2^{+}}^{\#1} \alpha \beta - 2 i k \sigma_{2^{+}}^{\#1} \alpha \beta = 0 5$	otal constraints:

Massive and massless spectra



(No massless particles)

Unitarity conditions

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