Particle spectrograph

Wave operator and propagator

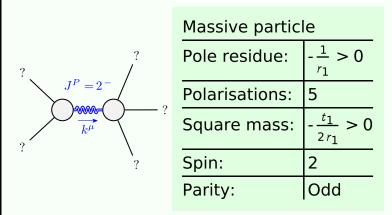
Multiplicities
П
П
$\partial_{\chi}\partial_{\beta}\partial^{\alpha}t^{\beta\chi} == \partial_{\chi}\partial^{\chi}\partial_{\beta}t^{\alpha\beta} + 2\partial_{\sigma}\partial^{\sigma}\partial_{\chi}\partial_{\beta}\sigma^{\alpha\beta\chi}$ 3
М
т
$2 \partial_{\delta} \partial_{\chi} \partial^{\alpha} \sigma^{\beta \chi \delta} + 2 \partial_{\delta} \partial^{\delta} \partial_{\chi} \sigma^{\alpha \beta \chi} = =$
2
$3 \partial_{\delta} \partial_{\chi} \partial_{\alpha} t^{\beta \chi} - 3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\alpha} t^{\chi \beta} -$
$3 \partial_{\delta} \partial_{\lambda} \partial_{\beta} \tau^{\alpha \chi} - 3 \partial_{\delta} \partial^{\delta} \partial_{\lambda} \partial^{\beta} \tau^{\chi \alpha} +$
$3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\chi} t^{\alpha\beta} + 3 \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial^{\chi} t^{\beta\alpha} +$
$4 i \eta^{\alpha\beta} k^{\lambda} \partial_{\phi} \partial^{\phi} \partial_{\varepsilon} \partial_{\chi} \sigma^{\delta \varepsilon}_{\delta}) == 0$
П

Quadratic (free) action	
== S	
$\iiint (\frac{1}{6} (6 t_1 \omega^{\alpha\prime}_{\alpha} \omega^{\theta}_{\prime} + 6 f^{\alpha\beta} \tau_{\alpha\beta})$	$\iiint (\frac{1}{6} (6t_1 \ \omega^{\alpha\prime}_{\alpha} \ \omega^{\theta}_{, \theta} + 6 \ f^{\alpha\beta} \ \tau_{\alpha\beta} + 6 \ \omega^{\alpha\beta\chi} \ \sigma_{\alpha\beta\chi} - 12t_1 \ \omega^{\theta}_{\alpha \ \theta} \ \partial_{,} f^{\alpha\prime} + 12t_1$
$\omega_{,\theta}^{\theta}\partial' f^{\alpha}_{\alpha}$	$\omega_{,\;\theta}^{\;\theta}\;\partial'f^{\alpha}_{\;\;\alpha}-6t_1\partial_if^{\;\theta}_{\;\;\theta}\partial'f^{\alpha}_{\;\;\alpha}-12r_1\partial_\beta\omega_{,\;\theta}^{\;\;\theta}\partial'\omega^{\alpha\beta}_{\;\;\alpha}+$
$12r_1\partial_i\omega_\beta^\theta$	$12r_1\partial_{,}\omega_{_{eta}_{$
$12t_1 \partial' f^{\alpha}_{\ \alpha} \partial_{\theta}$	$12t_1\partial'f^{lpha}_{}\partial_{ heta}f_{}^{}+12r_1\partial_{lpha}\omega^{lphaeta'}\partial_{ heta}\omega_{eta}^{,},$
$24 r_1 \partial' \omega^{\alpha \beta}_{\alpha}$	$24 r_1 \partial' \omega^{\alpha \beta}_{\alpha} \partial_{\theta} \omega_{\beta}^{\ \theta}$, - $12 r_1 \partial_{\alpha} \omega^{\alpha \beta'} \partial_{\theta} \omega_{\beta}^{\ \theta}$ +
$24 r_1 \partial' \omega^{\alpha \beta}_{\alpha} i$	$24r_1\partial'\omega^{\alpha\beta}{}_{\alpha}\partial_{\theta}\omega_{'\beta}^{\ \theta}+4t_1\ \omega_{'\theta\alpha}\ \partial^{\theta}f^{\alpha\prime}+4t_2\ \omega_{'\theta\alpha}\ \partial^{\theta}f^{\alpha\prime}-$
$4t_1\partial_{\alpha}f_{_{I}\theta}\partial^{\theta}f$	$4t_1\partial_{\alpha}f_{, heta}\partial^{ heta}f^{lpha\prime} + 2t_2\partial_{lpha}f_{, heta}\partial^{ heta}f^{lpha\prime} - 4t_1\partial_{lpha}f_{ heta\prime}\partial^{ heta}f^{lpha\prime} -$
$t_2 \partial_{\alpha} f_{ heta_I} \partial^{ heta} f^{ lpha_I}$	$t_2 \partial_{lpha} f_{eta_1} \partial^{eta} f^{lpha_1} + 2 t_1 \partial_{ec{f}} f_{lpha eta} \partial^{eta} f^{lpha_{ec{l}}} - t_2 \partial_{ec{f}} f_{lpha eta} \partial^{eta} f^{lpha_{ec{l}}} +$
$4t_1\partial_{ heta}f_{lpha_{\prime}}\partial^{ heta}f$	$4t_1 \partial_{\theta} f_{\alpha_l} \partial^{\theta} f^{\alpha_l} + t_2 \partial_{\theta} f_{\alpha_l} \partial^{\theta} f^{\alpha_l} + 2 t_1 \partial_{\theta} f_{ \alpha} \partial^{\theta} f^{\alpha_l} -$
$t_2 \partial_{\theta} f_{ \alpha} \partial^{\theta} f^{\alpha \prime}$	$t_2 \partial_{\theta} f_{\prime \alpha} \partial^{\theta} f^{\alpha\prime} + 2 (t_1 + t_2) \omega_{\alpha\prime\theta} \left(\omega^{\alpha\prime\theta} + 2 \partial^{\theta} f^{\alpha\prime} \right) +$
$2 \omega_{\alpha\theta_I} ((t_1 - 2))$	$2 \omega_{\alpha\theta_{1}} ((t_{1}-2t_{2}) \omega^{\alpha/\theta}+2(2t_{1}-t_{2}) \partial^{\theta}f^{\alpha\prime})$
$8r_1\partial_eta\omega_{lpha_I heta}\partial^eta$	$8r_1\partial_\beta\omega_{\alpha\prime\theta}\partial^\theta\omega^{\alpha\beta\prime} + 4r_1\partial_\beta\omega_{\alpha\theta\prime}\partial^\theta\omega^{\alpha\beta\prime} - 16r_1\partial_\beta\omega_{\prime\theta\alpha}$
$\partial^{\theta}\omega^{\alpha\beta'}$ - 4 Γ	$\partial^{\theta}\omega^{lphaeta_{1}}$ - $4r_{1}\partial_{,}\omega_{lphaeta heta}\partial^{ heta}\omega^{lphaeta_{'}}+4r_{1}\partial_{ heta}\omega_{lphaeta_{'}}\partial^{ heta}\omega^{lphaeta_{'}}+$
$4 r_1 \partial_{\theta} \omega_{\alpha B} \partial^{\theta}$	$4r_1\partial_{ heta}\omega_{_{lpha,lpha}}\partial^{ heta}\omega_{^{lpha}eta}))[t,ee,ec{y},ec{z}]dec{z}dydec{z}dt$

$ au_1^{\#2}$	0	0	0	$\frac{2ik}{t_1+2k^2t_1}$	$\frac{i\sqrt{2}}{(t_1 + 2k^2t_1)^2}$	0	$\frac{2 k^2 (2 k^2 r_1 + t_1)}{(t_1 + 2 k^2 t_1)^2}$	Į.į	
$\tau_{1^{-}}^{\#1}\alpha$	0	0	0	0	0	0	0	$ au_0^{\#2}$ $\sigma_0^{\#1}$	
$\sigma_{1}^{\#2}$	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	$\frac{i\sqrt{2}k(2k^2r_1+t_1)}{(t_1+2k^2t_1)^2}$	${f t}_0^{\#1} = {f t}_0^{\sharp}$	i √2 k
$\sigma_{1}^{\#1}{}_{\alpha}$	0	0	0	0 0 0		0	$-\frac{2ik}{t_1+2k^2t_1}$	$\sigma_{0^+}^{\#1}$	1
$\tau_{1}^{\#1}_{+\alpha\beta}$	$\frac{i\sqrt{2} k(t_1-2t_2)}{3(1+k^2)t_1t_2}$	$\frac{i k (t_1 + 4 t_2)}{3 (1 + k^2)^2 t_1 t_2}$	$\frac{k^2 (t_1 + 4t_2)}{3(1+k^2)^2 t_1 t_2}$		0	0	0		#1
$\sigma_{1}^{\#2}{}_{+}\alpha_{\beta}$	$\frac{\sqrt{2} (t_1 - 2t_2)}{3 (1 + k^2) t_1 t_2}$	$\frac{t_1 + 4t_2}{3(1+k^2)^2 t_1 t_2}$	$-\frac{i k (t_1 + 4 t_2)}{3 (1 + k^2)^2 t_1 t_2}$	0	0	0	0	$\omega_{1}^{#1}$ $\omega_{1}^{#2}$ $f_{1}^{#1}$	
$\sigma_{1}^{\#1}\!$	$\frac{2(t_1+t_2)}{3t_1t_2}$	$\frac{\sqrt{2} (t_1 - 2t_2)}{3 (1 + k^2) t_1 t_2}$	$-\frac{i\sqrt{2}k(t_1-2t_2)}{3(1+k^2)t_1t_2}$	0	0	0	0	u) ₁ ^{#1}
	$\sigma_{1}^{\#1} + \alpha^{eta}$	$\sigma_{1}^{\#2} + \alpha^{eta}$	$\tau_1^{#1} + \alpha \beta$	$\sigma_{1}^{\#_{1}} +^{\alpha}$	$\sigma_1^{\#2} +^{lpha}$	$ au_1^{\#_1} + ^{lpha}$	$\tau_1^{\#2} +^{\alpha}$	f	#1 1 -#2 1

					3%				0	0	+ 17			
σ_{0}^{r}	0	0	0	$\frac{1}{t_2}$	$\sigma_{2}^{\#1}{}_{lphaeta\chi}$	0	0	$\frac{2}{2k^2r_1+t_1}$))	k ² r ₁ .	4		
t ⁰ +	0	0	0	0		. 4	1 15	1 (4	$\frac{i k t_1}{\sqrt{2}}$	$k^2 t_1$	C			
t ₀ +	$i \sqrt{2} k $ (1+2 k ²) ² t ₁	$\frac{2k^2}{(1+2k^2)^2t_1}$	0	0	$\tau_2^{\#1}_{+}\alpha\beta$	$2 i \sqrt{2} k$ (1+2 k^2) ² t_1	$\frac{4k^2}{(1+2k^2)^2 t_1}$	0	<u>f1</u> 2	$\frac{ikt_1}{\sqrt{2}}$				
	(1+	I			3	- 12	t ₁			U	$v_0^{\#1}$		$f_{0+}^{#1}$	$f_{0}^{#2}$
+	²) ² t ₁	$\frac{2}{2}k$ $2)^2t_1$			$\sigma_{2}^{\#1}{}_{lphaeta}$	$\frac{2}{(1+2k^2)^2t_1}$	$\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$	0	$\omega_{0}^{\#1}$ †		$-t_1$	ĪΛ	$\sqrt{2} kt_1$	0
00+	$\frac{1}{(1+2k^2)^2t_1}$	$\frac{i\sqrt{2}k}{(1+2k^2)^2t_1}$	0	0	0	(1+	2 (1+		$f_{0}^{#1}$ †	-Ī V	$\sqrt{2} k$	$t_1 - 2$	$2k^2t_1$	0
	i	+	+			$\sigma_2^{\#1} + \alpha \beta$	$\tau_{2}^{\#1} + \alpha \beta$	$+^{\alpha eta \chi}$	$f_{0^{+}}^{#2}$ †		0		0	0
	$\sigma_{0}^{\#1}$ 1	$\tau_0^{\#1}$	$\tau_{0}^{\#2}$	$\sigma_{0}^{\#1}\dagger$		$\sigma_{2}^{\#1}$	$\tau_2^{\#1}$	$\sigma_{2}^{#1} + \alpha \beta \chi$	$\omega_0^{\sharp 1}$ †		0		0	0
		$\omega_1^{\#}$	$\omega_{1^{+}\alpha\beta}^{\#1}$ $\omega_{1^{+}\alpha\beta}^{\#2}$		β	$f_{1^{+}\alpha\beta}^{\#1}$		$\omega_1^{\#1}$	$\omega_{1-\alpha}^{\sharp 1}$ $\omega_{1-\alpha}^{\sharp 2}$ f		$f_{1-\alpha}^{\#1}$	$f_{1}^{\#1}_{\alpha} f_{1}^{\#2}_{\alpha}$		
$\omega_1^{\#}$	$^{1}_{+}$ † $^{\alpha\beta}$	$\frac{1}{6}$ ($t_1 + $	⊦ 4 t ₂	,)	$-\frac{t_1-2t_2}{3\sqrt{2}}$	2	$-\frac{ik(t_1)}{3}$	-2 <i>t</i> 2) √2	0		0	0	0	
$\omega_1^{\scriptscriptstyle\#}$	$^{2}+^{\alpha\beta}$	- <u>t1</u> -	2 <i>t</i> 2 √2		<i>t</i> ₁ + <i>t</i> ₂ 3		$\frac{1}{3}\bar{l}k(t_1$	$+t_{2}$)	0		0	0	0	
$f_1^{\#}$	$^{\pm 1}_{+}$ † $^{\alpha\beta}$	<u>i k (t</u> 1	-2 <i>t</i> 2) √2	$-\frac{1}{3}$	ī k (t ₁	+ t ₂)	$\frac{1}{3} k^2 (t_1$	$+t_{2}$)	0		0	0	0	
$\omega_1^{\#1} \dagger^{lpha}$		0		0		0		$-k^2 r_1$	<u>t</u> 1 -	$\frac{t_1}{\sqrt{2}}$	0	īkt ₁		
$\omega_1^{\#2} \uparrow^{\alpha}$		0 0		0	0			$\frac{t_1}{\sqrt{2}}$		0	0	0		
$f_1^{\#1} \dagger^{\alpha}$		0			0		0		0		0	0	0	
$f_{1}^{#2} \dagger^{\alpha}$		0			0		0		- i k t ₁	L	0	0	0	

Massive and massless spectra



(No massless particles)

Unitarity conditions

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