

Particle spectrograph

Wave operator and propagator

Quadratic (free) action

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$$\int \int \int \int (\frac{1}{6} (6 f^{\alpha \beta} \tau_{\alpha \beta} + 6 \omega^{\alpha \beta \chi} \sigma_{\alpha \beta \chi} - 3 r_3 \partial_\beta \omega_{\theta \beta} \partial'_\theta \omega_{\beta \theta}^{\alpha \beta} - 3 r_3 \partial_\beta \omega_{\beta \theta}^{\alpha \beta} \partial'_\theta \omega_{\alpha \theta}^{\alpha \beta} - 3 r_3 \partial_\alpha \omega^{\alpha \beta \gamma} \partial_\theta \omega_{\beta \gamma}^{\theta} + 6 r_3 \partial'_\alpha \omega_{\beta \gamma}^{\alpha \beta} \partial_\theta \omega_{\beta \gamma}^{\theta} - 3 r_3 \partial_\alpha \omega^{\alpha \beta \gamma} \partial_\theta \omega_{\beta \gamma}^{\theta} + 6 r_3 \partial'_\alpha \omega_{\beta \gamma}^{\alpha \beta} \partial_\theta \omega_{\beta \gamma}^{\theta} + 4 t_2 \omega_{\beta \theta}^{\alpha \beta} \partial_\alpha \omega_{\beta \theta}^{\theta} + 2 t_2 \partial_\alpha f_{\beta \theta}^{\alpha \beta} - t_2 \partial_\alpha f_{\beta \theta}^{\alpha \beta} - t_2 \partial_\alpha f_{\beta \theta}^{\alpha \beta} \partial_\theta f_{\alpha \theta}^{\theta} - t_2 \partial_\alpha f_{\beta \theta}^{\alpha \beta} \partial_\theta f_{\alpha \theta}^{\theta} + 2 t_2 \omega_{\alpha \theta}^{\alpha \beta} (\omega^{\alpha \theta} + 2 \partial^\theta f^{\alpha \beta}) + 8 r_2 \partial_\beta \omega_{\alpha \theta}^{\alpha \beta} \partial^\theta \omega_{\alpha \theta}^{\alpha \beta} - 4 r_2 \partial_\beta \omega_{\alpha \theta}^{\alpha \beta} \partial^\theta \omega_{\alpha \theta}^{\alpha \beta} + 4 r_2 \partial_\beta \omega_{\alpha \theta}^{\alpha \beta} \partial^\theta \omega_{\alpha \theta}^{\alpha \beta} - 24 r_3 \partial_\beta \omega_{\alpha \theta}^{\alpha \beta} \partial^\theta \omega_{\alpha \theta}^{\alpha \beta} - 2 r_2 \partial_\beta \omega_{\alpha \theta}^{\alpha \beta} \partial^\theta \omega_{\alpha \theta}^{\alpha \beta} + 2 r_2 \partial_\beta \omega_{\alpha \theta}^{\alpha \beta} \partial^\theta \omega_{\alpha \theta}^{\alpha \beta} - 4 r_2 \partial_\beta \omega_{\alpha \theta}^{\alpha \beta} \partial^\theta \omega_{\alpha \theta}^{\alpha \beta} + 6 r_5 \partial_\beta \omega_{\alpha \theta}^{\alpha \beta} \partial^\theta \omega_{\alpha \theta}^{\alpha \beta} + 6 r_5 \partial_\beta \omega_{\alpha \theta}^{\alpha \beta} \partial^\theta \omega_{\alpha \theta}^{\alpha \beta} - 6 r_5 \partial_\beta \omega_{\alpha \theta}^{\alpha \beta} \partial^\theta \omega_{\alpha \theta}^{\alpha \beta} + 12 r_5 \partial_\beta \omega_{\alpha \theta}^{\alpha \beta} \partial^\theta \omega_{\alpha \theta}^{\alpha \beta} + 6 r_5 \partial_\beta \omega_{\alpha \theta}^{\alpha \beta} \partial^\theta \omega_{\alpha \theta}^{\alpha \beta} - 12 r_5 \partial_\beta \omega_{\alpha \theta}^{\alpha \beta} \partial^\theta \omega_{\alpha \theta}^{\alpha \beta})) [t, x, y, z] dz dy dx dt$$

$\sigma_{1+}^{\#1} \dagger^{\alpha \beta}$	$\sigma_{1+}^{\#2} \dagger^{\alpha \beta}$	$\tau_{1+}^{\#1} \dagger^{\alpha \beta}$	$\sigma_{1+}^{\#1} \dagger^{\alpha}$	$\sigma_{1+}^{\#2} \dagger^{\alpha}$	$\tau_{1+}^{\#1} \dagger^{\alpha}$	$\tau_{1+}^{\#2} \dagger^{\alpha}$
$\frac{1}{k^2 (2 r_3 + r_5)}$	$-\frac{\sqrt{2}}{k^2 (1 + k^2) (2 r_3 + r_5)}$	$-\frac{i \sqrt{2}}{k (1 + k^2) (2 r_3 + r_5)}$	0	0	0	0
$-\frac{\sqrt{2}}{k^2 (1 + k^2) (2 r_3 + r_5)}$	$\frac{3 k^2 (2 r_3 + r_5) + 2 t_2}{(k + k^3)^2 (2 r_3 + r_5) t_2}$	$\frac{i (3 k^2 (2 r_3 + r_5) + 2 t_2)}{k (1 + k^2)^2 (2 r_3 + r_5) t_2}$	0	0	0	0
$\frac{i \sqrt{2}}{k (1 + k^2) (2 r_3 + r_5)}$	$-\frac{i (3 k^2 (2 r_3 + r_5) + 2 t_2)}{k (1 + k^2)^2 (2 r_3 + r_5) t_2}$	$\frac{3 k^2 (2 r_3 + r_5) + 2 t_2}{(1 + k^2)^2 (2 r_3 + r_5) t_2}$	0	0	0	0
0	0	0	$\frac{2}{k^2 (r_3 + 2 r_5)}$	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

$\omega_{1+}^{\#1} \dagger^{\alpha \beta}$	$\omega_{1+}^{\#2} \dagger^{\alpha \beta}$	$f_{1+}^{\#1} \dagger^{\alpha \beta}$	$\omega_{1+}^{\#1} \dagger^{\alpha}$	$\omega_{1+}^{\#2} \dagger^{\alpha}$	$f_{1+}^{\#1} \dagger^{\alpha}$	$f_{1+}^{\#2} \dagger^{\alpha}$
$k^2 (2 r_3 + r_5) + \frac{2 t_2}{3}$	$\frac{\sqrt{2} t_2}{3}$	$\frac{1}{3} i \sqrt{2} k t_2$	0	0	0	0
$\frac{\sqrt{2} t_2}{3}$	$\frac{t_2}{3}$	$\frac{i k t_2}{3}$	0	0	0	0
$-\frac{1}{3} i \sqrt{2} k t_2$	$-\frac{1}{3} i k t_2$	$\frac{k^2 t_2}{3}$	0	0	0	0
0	0	0	$\frac{1}{2} k^2 (r_3 + 2 r_5)$	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau_{0+}^{\#2} == 0$	1
$\tau_{0+}^{\#1} == 0$	1
$\sigma_{0+}^{\#1} == 0$	1
$\tau_{1-}^{\#2 \alpha} == 0$	3
$\tau_{1-}^{\#1 \alpha} == 0$	3
$\sigma_{1-}^{\#2 \alpha} == 0$	3
$\tau_{1+}^{\#1 \alpha \beta} + i k \sigma_{1+}^{\#2 \alpha \beta} == 0$	3
$\sigma_{2-}^{\#1 \alpha \beta \chi} == 0$	5
$\tau_{2+}^{\#1 \alpha \beta} == 0$	5
Total constraints:	25

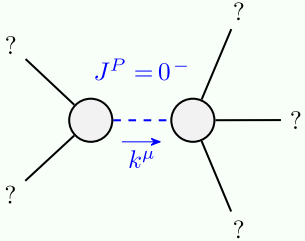
$\sigma_{0+}^{\#1} \dagger$	$\tau_{0+}^{\#1} \dagger$	$\tau_{0+}^{\#2} \dagger$	$\sigma_{0-}^{\#1} \dagger$
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$\frac{1}{k^2 r_2 + t_2}$

$\sigma_{2+}^{\#1} \dagger^{\alpha \beta}$	$\tau_{2+}^{\#1} \dagger^{\alpha \beta}$	$\sigma_{2-}^{\#1} \dagger^{\alpha \beta \chi}$
$-\frac{2}{3 k^2 r_3}$	0	0
0	0	0
0	0	0

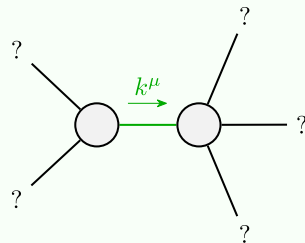
$\omega_{2+}^{\#1} \dagger^{\alpha \beta}$	$\omega_{2+}^{\#1} \dagger^{\alpha \beta}$	$\omega_{2+}^{\#1} \dagger^{\alpha \beta}$	$\omega_{2+}^{\#1} \dagger^{\alpha \beta}$
$-\frac{3 k^2 r_3}{2}$	0	0	0
0	0	0	0
0	0	0	0

$\omega_{2-}^{\#1} \dagger^{\alpha \beta \chi}$	$\omega_{2-}^{\#1} \dagger^{\alpha \beta \chi}$	$\omega_{2-}^{\#1} \dagger^{\alpha \beta \chi}$	$\omega_{2-}^{\#1} \dagger^{\alpha \beta \chi}$
0	0	0	0
0	0	0	0
0	0	0	0

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{r_2} > 0$
Polarisations:	1
Square mass:	$-\frac{t_2}{r_2} > 0$
Spin:	0
Parity:	Odd



Quadratic pole	
Pole residue:	$-\frac{1}{r_3 (2 r_3 + r_5) (r_3 + 2 r_5) p^2} > 0$
Polarisations:	2

Unitarity conditions

$r_2 < 0 \& \& r_3 < 0 \& \& r_5 < -\frac{r_3}{2} \& \& t_2 > 0 \parallel r_2 < 0 \& \& r_3 < 0 \& \& r_5 > -2 r_3 \& \& t_2 > 0 \parallel r_2 < 0 \& \& r_3 > 0 \& \& -2 r_3 < r_5 < -\frac{r_3}{2} \& \& t_2 > 0$