

Particle spectrograph

Wave operator and propagator

	$\sigma_{1^+}^{\#1} + \alpha\beta$	$\sigma_{1^+}^{\#2} + \alpha\beta$	$\tau_{1^+}^{\#1} + \alpha\beta$	$\sigma_{1^+}^{\#1} - \alpha$	$\sigma_{1^+}^{\#2} - \alpha$	$\tau_{1^+}^{\#1} - \alpha$	$\tau_{1^+}^{\#2} - \alpha$
$\sigma_{1^+}^{\#1} + \alpha\beta$	$\frac{1}{k^2(2r_3+r_5)}$	0	0	0	0	0	0
$\sigma_{1^+}^{\#2} + \alpha\beta$	0	0	0	0	0	0	0
$\tau_{1^+}^{\#1} + \alpha\beta$	0	0	0	0	0	0	0
$\sigma_{1^+}^{\#1} + \alpha$	0	0	0	$\frac{2}{k^2(r_3+2r_5)}$	$\frac{2\sqrt{2}}{k^2(1+2k^2)(r_3+2r_5)}$	0	$\frac{4i}{k(1+2k^2)(r_3+2r_5)}$
$\sigma_{1^+}^{\#2} + \alpha$	0	0	0	$\frac{2\sqrt{2}}{k^2(1+2k^2)(r_3+2r_5)}$	$\frac{3k^2(r_3+2r_5)+4t_3}{(k+2k^3)^2(r_3+2r_5)t_3}$	0	$\frac{i\sqrt{2}(3k^2(r_3+2r_5)+4t_3)}{k(1+2k^2)^2(r_3+2r_5)t_3}$
$\tau_{1^+}^{\#1} + \alpha$	0	0	0	0	0	0	0
$\tau_{1^+}^{\#2} + \alpha$	0	0	0	$-\frac{4i}{k(1+2k^2)(r_3+2r_5)}$	$-\frac{i\sqrt{2}(3k^2(r_3+2r_5)+4t_3)}{k(1+2k^2)^2(r_3+2r_5)t_3}$	0	$\frac{6k^2(r_3+2r_5)+8t_3}{(1+2k^2)^2(r_3+2r_5)t_3}$

Quadratic (free) action

§ 5

$$\begin{aligned} & \int \int \int \left(\frac{1}{6} (-4t_3 \omega_{\alpha}^{\alpha i} \omega_{\kappa}^{\kappa} \omega_{\kappa}^{\kappa} f^{\alpha \beta} \tau_{\alpha \beta} + 6 \omega_{\alpha \beta \chi}^{\alpha \beta \chi} \sigma_{\alpha \beta \chi} + 8t_3 \omega_{\alpha}^{\kappa} \omega_{\kappa}^{\kappa} \partial_{\kappa} f^{\alpha i} - 8t_3 \omega_{\kappa}^{\kappa} \omega_{\kappa}^{\kappa} \partial_{\kappa} f^{\alpha i} - \right. \\ & \quad \partial_{\kappa} f^{\alpha} + 4t_3 \partial_{\kappa} f^{\kappa} \partial_{\kappa} f^{\alpha} - 3r_3 \partial_{\beta} \omega_{\kappa}^{\theta} \partial_{\theta} \omega_{\kappa}^{\alpha \beta} - 3r_3 \partial_{\kappa} \omega_{\beta}^{\theta} \partial_{\theta} \omega_{\alpha}^{\alpha \beta} - \\ & \quad 3r_3 \partial_{\alpha} \omega_{\beta}^{\alpha \beta i} \partial_{\theta} \omega_{\beta}^{\theta} + 6r_3 \partial_{\kappa} \omega_{\alpha}^{\alpha \beta} \partial_{\theta} \omega_{\beta}^{\theta} - 3r_3 \partial_{\alpha} \omega_{\beta}^{\alpha \beta i} \partial_{\theta} \omega_{\kappa}^{\theta} + \\ & \quad 6r_3 \partial_{\kappa} \omega_{\beta}^{\alpha \beta} \partial_{\theta} \omega_{\kappa}^{\theta} + 8r_2 \partial_{\beta} \omega_{\alpha i \theta}^{\alpha \beta i} \partial_{\theta} \omega_{\alpha \theta}^{\alpha \beta i} - 4r_2 \partial_{\beta} \omega_{\alpha \theta}^{\alpha \beta i} \partial_{\theta} \omega_{\alpha \theta}^{\alpha \beta i} + \\ & \quad 4r_2 \partial_{\beta} \omega_{\theta \alpha}^{\alpha \beta i} \partial_{\theta} \omega_{\theta \alpha}^{\alpha \beta i} - 24r_3 \partial_{\beta} \omega_{\theta \alpha}^{\alpha \beta i} \partial_{\theta} \omega_{\alpha \beta}^{\alpha \beta i} - 2r_2 \partial_{\kappa} \omega_{\alpha \beta \theta}^{\alpha \beta i} \partial_{\theta} \omega_{\kappa}^{\alpha \beta i} + 2r_2 \partial_{\theta} \omega_{\alpha \beta i}^{\alpha \beta i} \\ & \quad \partial_{\theta} \omega_{\alpha \beta}^{\alpha \beta i} - 4r_2 \partial_{\theta} \omega_{\alpha \beta}^{\alpha \beta i} \partial_{\theta} \omega_{\alpha \beta}^{\alpha \beta i} + 6r_5 \partial_{\kappa} \omega_{\theta}^{\kappa} \partial_{\theta} \omega_{\alpha}^{\alpha i} - 6r_5 \partial_{\alpha} \omega_{\kappa}^{\kappa} \partial_{\theta} \omega_{\alpha}^{\alpha i} + \\ & \quad 4t_3 \partial_{\kappa} f^{\alpha i} \partial_{\kappa} f^{\kappa} - 8t_3 \partial_{\kappa} f^{\alpha} \partial_{\kappa} f^{\kappa} - 6r_5 \partial_{\alpha} \omega_{\kappa}^{\alpha i \theta} \partial_{\kappa} \omega_{\theta}^{\kappa} + 12r_5 \partial_{\theta} \omega_{\alpha}^{\alpha i} \partial_{\kappa} \omega_{\theta}^{\kappa} + \\ & \quad \left. 6r_5 \partial_{\alpha} \omega_{\theta}^{\alpha i \theta} \partial_{\kappa} \omega_{\theta}^{\kappa} - 12r_5 \partial_{\theta} \omega_{\alpha}^{\alpha i} \partial_{\kappa} \omega_{\theta}^{\kappa} \right) [t, x, y, z] dz dy dx dt \end{aligned}$$

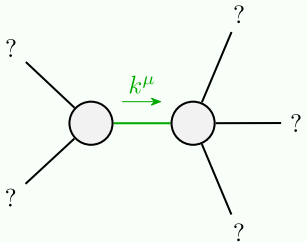
	$\omega_{1^+}^{\#1} + \alpha\beta$	$\omega_{1^+}^{\#2} + \alpha\beta$	$f_{1^+}^{\#1} + \alpha\beta$	$\omega_{1^+}^{\#1} - \alpha$	$\omega_{1^+}^{\#2} - \alpha$	$f_{1^+}^{\#1} - \alpha$	$f_{1^+}^{\#2} - \alpha$
$\omega_{1^+}^{\#1} + \alpha\beta$	$k^2(2r_3 + r_5)$	0	0	0	0	0	0
$\omega_{1^+}^{\#2} + \alpha\beta$	0	0	0	0	0	0	0
$f_{1^+}^{\#1} + \alpha\beta$	0	0	0	0	0	0	0
$\omega_{1^+}^{\#1} + \alpha$	0	0	0	$k^2(\frac{r_3}{2} + r_5) + \frac{2t_3}{3}$	$-\frac{\sqrt{2}t_3}{3}$	0	$-\frac{2}{3}i k t_3$
$\omega_{1^+}^{\#2} + \alpha$	0	0	0	$-\frac{\sqrt{2}t_3}{3}$	$\frac{t_3}{3}$	0	$\frac{1}{3}i\sqrt{2} k t_3$
$f_{1^+}^{\#1} + \alpha$	0	0	0	0	0	0	0
$f_{1^+}^{\#2} + \alpha$	0	0	0	$\frac{2i k t_3}{3}$	$-\frac{1}{3}i\sqrt{2} k t_3$	0	$\frac{2k^2 t_3}{3}$

Source constraints/gauge generators	Multiplicities
$\tau_{0+}^{\#2} == 0$	1
$\tau_{0+}^{\#1} - 2 \, i \, k \, \sigma_{0+}^{\#1} == 0$	1
$\tau_{1-}^{\#2 \alpha} + 2 \, i \, k \, \sigma_{1-}^{\#2 \alpha} == 0$	3
$\tau_{1-}^{\#1 \alpha} == 0$	3
$\tau_{1+}^{\#1 \alpha \beta} == 0$	3
$\sigma_{1+}^{\#2 \alpha \beta} == 0$	3
$\sigma_{2-}^{\#1 \alpha \beta} x == 0$	5
$\tau_{2+}^{\#1 \alpha \beta} == 0$	5
Total constraints:	24

$$\begin{array}{c}
 \omega_{2^+}^{\#1} \quad f_{2^+}^{\#1} \quad \omega_{2^-}^{\#1} \\
 \alpha\beta \quad \alpha\beta \quad \alpha\beta\chi
 \end{array}
 \begin{array}{|c|c|c|}
 \hline
 \omega_{2^+}^{\#1} \uparrow \alpha\beta & -\frac{3k^2 r_3}{2} & 0 \\
 \hline
 f_{2^+}^{\#1} \uparrow \alpha\beta & 0 & 0 \\
 \hline
 \omega_{2^-}^{\#1} \uparrow \alpha\beta\chi & 0 & 0 \\
 \hline
 \end{array}
 \begin{array}{c}
 \sigma_{2^+}^{\#1} \quad \tau_{2^+}^{\#1} \quad \sigma_{2^-}^{\#1} \\
 \alpha\beta \quad \alpha\beta \quad \alpha\beta\chi
 \end{array}
 \begin{array}{|c|c|c|}
 \hline
 \sigma_{2^+}^{\#1} \uparrow \alpha\beta & -\frac{2}{3k^2 r_3} & 0 \\
 \hline
 \tau_{2^+}^{\#1} \uparrow \alpha\beta & 0 & 0 \\
 \hline
 \sigma_{2^-}^{\#1} \uparrow \alpha\beta\chi & 0 & 0 \\
 \hline
 \end{array}$$

$\sigma_0^{\#1} \dagger$	$\frac{1}{(1+2k^2)^2} t_3$	$-\frac{i\sqrt{2}k}{(1+2k^2)^2} t_3$	$\tau_0^{\#1}$	$\tau_0^{\#2}$	$\sigma_0^{\#1}$
$\tau_0^{\#1} \dagger$	$\frac{i\sqrt{2}k}{(1+2k^2)^2} t_3$	$\frac{2k^2}{(1+2k^2)^2} t_3$	$\tau_0^{\#1} \dagger$	$\tau_0^{\#2}$	$\sigma_0^{\#1}$
$\tau_0^{\#2} \dagger$	0	0	$\tau_0^{\#1} \dagger$	0	$\sigma_0^{\#1}$
$\sigma_0^{\#1} \dagger$	0	0	$\tau_0^{\#1} \dagger$	0	$\sigma_0^{\#1}$

Massive and massless spectra



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

(No massive particles)

Unitarity conditions

$$r_3 < 0 \&\& (r_5 < -\frac{r_3}{2} \parallel r_5 > -2r_3) \parallel r_3 > 0 \&\& -2r_3 < r_5 < -\frac{r_3}{2}$$