

Particle spectrograph

Wave operator and propagator

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

Quadratic (free) action

$$\begin{aligned}
 S = & \iiint (\frac{1}{6} f^{\alpha\beta} \tau_{\alpha\beta} + 6 \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - 3 r_3 \partial_\beta \omega_{,\theta}^{\alpha\beta} \partial' \omega_{\alpha}^{\theta} \partial' \omega_{\beta}^{\alpha\beta} - 3 \\
 & r_3 \partial_\alpha \omega^{\alpha\beta\prime} \partial_\theta \omega_{\beta,\prime}^{\theta} + 6 r_3 \partial' \omega_{\alpha}^{\alpha\beta} \partial_\theta \omega_{\beta,\prime}^{\theta} - 3 r_3 \partial_\alpha \omega^{\alpha\beta\prime} \partial_\theta \omega_{,\beta}^{\theta} + \\
 & 6 r_3 \partial' \omega_{\alpha}^{\alpha\beta} \partial_\theta \omega_{,\beta}^{\theta} + 4 t_2 \omega_{,\theta\alpha} \partial^\theta f^{\alpha\prime} + 2 t_2 \partial_\alpha f_{,\theta} \partial^\theta f^{\alpha\prime} - t_2 \partial_\alpha f_{\theta,\prime} \partial^\theta f^{\alpha\prime} - \\
 & t_2 \partial_{,\prime} f_{\alpha\theta} \partial^\theta f^{\alpha\prime} + t_2 \partial_\theta f_{\alpha,\prime} \partial^\theta f^{\alpha\prime} - t_2 \partial_\theta f_{,\alpha} \partial^\theta f^{\alpha\prime} - 4 t_2 \omega_{\alpha\theta,\prime} (\omega^{\alpha\theta} + \partial^\theta f^{\alpha\prime}) + \\
 & 2 t_2 \omega_{\alpha\theta} (\omega^{\alpha\theta} + 2 \partial^\theta f^{\alpha\prime}) - 24 r_3 \partial_\beta \omega_{,\theta\alpha} \partial^\theta \omega_{\alpha}^{\beta\prime} + 6 r_5 \partial_{,\theta} \omega_{\alpha}^{\beta\prime} \partial^\theta \omega_{\beta,\prime}^{\alpha} - \\
 & 6 r_5 \partial_\theta \omega_{,\prime}^{\kappa} \partial^\theta \omega_{\alpha}^{\alpha\prime} - 6 r_5 \partial_\alpha \omega^{\alpha\prime\theta} \partial_{\kappa} \omega_{,\prime}^{\kappa} + 12 r_5 \partial^\theta \omega_{\alpha}^{\alpha\prime} \partial_{\kappa} \omega_{\beta,\prime}^{\kappa} + \\
 & 6 r_5 \partial_\alpha \omega^{\alpha\prime\theta} \partial_{\kappa} \omega_{\theta,\prime}^{\kappa} - 12 r_5 \partial^\theta \omega_{\alpha}^{\alpha\prime} \partial_{\kappa} \omega_{\theta,\prime}^{\kappa})) [t, x, y, z] dz dy dx dt
 \end{aligned}$$

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

Source constraints/gauge generators	
SO(3) irreps	Multiplicities
$\sigma_{0+}^{\#1} == 0$	1
$\tau_{0+}^{\#1} == 0$	1
$\tau_{0+}^{\#2} == 0$	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

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

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

$\omega_{0+}^{\#1} \dagger$	$f_{0+}^{\#1} \dagger$	$f_{0+}^{\#2} \dagger$	$\omega_{0-}^{\#1}$
$\omega_{0+}^{\#1} \dagger$	0	0	0
$f_{0+}^{\#1} \dagger$	0	0	0
$f_{0+}^{\#2} \dagger$	0	0	0
$\omega_{0-}^{\#1} \dagger$	0	0	t_2

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

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

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