

Particle spectrograph

Wave operator and propagator

$\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1+}^{\#2}$	$\tau_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1+}^{\#1}$	$\sigma_{1+}^{\#2}$	$\tau_{1+}^{\#1}$	$\tau_{1+}^{\#2}$
$\frac{2(t_1+t_2)}{3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2)}$	$\frac{\sqrt{2}(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$\frac{i\sqrt{2}k(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	0	0	0	0
$\frac{\sqrt{2}(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$\frac{6k^2(2r_1+r_5)+t_1+4t_2}{(1+k^2)^2(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$\frac{ik(6k^2(2r_1+r_5)+t_1+4t_2)}{(1+k^2)^2(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	0	0	0	0
$-\frac{i\sqrt{2}k(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$-\frac{ik(6k^2(2r_1+r_5)+t_1+4t_2)}{(1+k^2)^2(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$\frac{k^2(6k^2(2r_1+r_5)+t_1+4t_2)}{(1+k^2)^2(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	0	0	0	0
0	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	0	$\frac{2ik}{t_1+2k^2t_1}$
0	0	0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	$\frac{-2k^2(r_1+r_5)+t_1}{(t_1+2k^2t_1)^2}$	0	$-\frac{i\sqrt{2}k(2k^2(r_1+r_5)+t_1)}{(t_1+2k^2t_1)^2}$
0	0	0	0	0	0	0
0	0	0	$-\frac{2ik}{t_1+2k^2t_1}$	$\frac{i\sqrt{2}k(2k^2(r_1+r_5)+t_1)}{(t_1+2k^2t_1)^2}$	0	$\frac{-4k^4(r_1+r_5)+2k^2t_1}{(t_1+2k^2t_1)^2}$

Source constraints/gauge generators	Multiplicities
$\tau_{0+}^{\#2} == 0$	1
$\tau_{0+}^{\#1} - 2ik\sigma_{0+}^{\#1} == 0$	1
$\tau_{1-}^{\#2\alpha} + 2ik\sigma_{1-}^{\#2\alpha} == 0$	3
$\tau_{1-}^{\#1\alpha} == 0$	3
$\tau_{1+}^{\#1\alpha\beta} + ik\sigma_{1+}^{\#2\alpha\beta} == 0$	3
$\tau_{2+}^{\#1\alpha\beta} - 2ik\sigma_{2+}^{\#1\alpha\beta} == 0$	5
Total constraints:	16

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

$\omega_{2+}^{\#1} \dagger^{\alpha\beta}$	$f_{2+}^{\#1}$	$\omega_{2-}^{\#1}$
$\frac{t_1}{2}$	$-\frac{ik t_1}{\sqrt{2}}$	0
$f_{2+}^{\#1} \dagger^{\alpha\beta}$	$\frac{ik t_1}{\sqrt{2}}$	0
$\omega_{2-}^{\#1} \dagger^{\alpha\beta\chi}$	0	$k^2r_1 + \frac{t_1}{2}$

$\sigma_{0+}^{\#1} \dagger$	$\sigma_{0+}^{\#1}$	$\tau_{0+}^{\#1}$	$\tau_{0+}^{\#2}$	$\sigma_{0+}^{\#1}$
$-\frac{1}{(1+2k^2)^2}t_1$	$\frac{i\sqrt{2}k}{(1+2k^2)^2}t_1$	0	0	0
$-\frac{i\sqrt{2}k}{(1+2k^2)^2}t_1$	$-\frac{2k^2}{(1+2k^2)^2}t_1$	0	0	0
$\tau_{0+}^{\#1} \dagger$	0	0	0	$\frac{1}{t_2}$

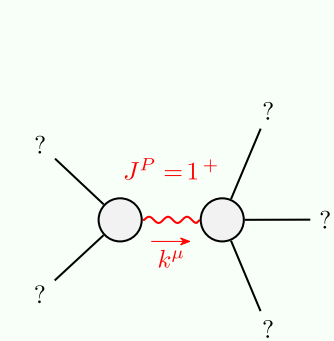
$\omega_{0+}^{\#1} \dagger$	$f_{0+}^{\#1}$	$f_{0+}^{\#2}$	$\omega_{0+}^{\#1}$
-t ₁	$i\sqrt{2}kt_1$	0	0
$-i\sqrt{2}kt_1$	$-2k^2t_1$	0	0
0	0	0	0
0	0	0	t ₂

Quadratic (free) Lagrangian density

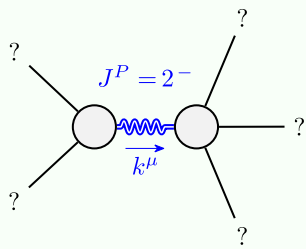
$$-t_1 \omega_{\kappa\alpha}^{\alpha\prime} \omega_{\kappa\lambda}^{\kappa\prime} - \frac{1}{3} t_1 \omega_{\kappa\lambda}^{\kappa\lambda\prime} \omega_{\kappa\lambda}^{\prime} + \frac{2}{3} t_2 \omega_{\kappa\lambda}^{\kappa\lambda\prime} \omega_{\kappa\lambda}^{\prime} + \frac{1}{3} t_1 \omega_{\kappa\lambda}^{\prime} \omega_{\kappa\lambda}^{\kappa\lambda\prime} +$$
$$\frac{1}{3} t_2 \omega_{\kappa\lambda}^{\prime} \omega_{\kappa\lambda}^{\kappa\lambda\prime} + f^{\alpha\beta} \tau_{\alpha\beta} + \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - r_5 \partial_\lambda \omega_{\kappa\lambda}^{\kappa\lambda} \partial^\lambda \omega_{\lambda\alpha}^{\alpha} - \frac{2}{3} r_1 \partial^\beta \omega^{\theta\alpha}_{\kappa} \partial_\theta \omega_{\alpha\beta}^{\kappa} -$$
$$\frac{2}{3} r_1 \partial_\theta \omega_{\alpha\beta}^{\kappa} \partial_\kappa \omega^{\alpha\beta\theta} + \frac{2}{3} r_1 \partial_\theta \omega_{\alpha\beta}^{\kappa} \partial_\kappa \omega^{\theta\alpha\beta} - r_5 \partial_\alpha \omega_{\lambda\theta}^{\alpha} \partial_\kappa \omega^{\theta\kappa\lambda} +$$
$$r_5 \partial_\theta \omega_{\lambda\alpha}^{\alpha} \partial_\kappa \omega^{\theta\kappa\lambda} - r_5 \partial_\alpha \omega_{\lambda\theta}^{\alpha} \partial_\kappa \omega^{\kappa\lambda\theta} + 2 r_5 \partial_\theta \omega_{\lambda\alpha}^{\alpha} \partial_\kappa \omega^{\kappa\lambda\theta} - \frac{1}{3} t_1 \partial^\alpha f_{\theta\kappa} \partial^\kappa f_{\alpha}^{\theta} +$$
$$\frac{1}{6} t_2 \partial^\alpha f_{\theta\kappa} \partial^\kappa f_{\alpha}^{\theta} - \frac{2}{3} t_1 \partial^\alpha f_{\kappa\theta} \partial^\kappa f_{\alpha}^{\theta} - \frac{1}{6} t_2 \partial^\alpha f_{\kappa\theta} \partial^\kappa f_{\alpha}^{\theta} - \frac{1}{3} t_1 \partial^\alpha f_{\kappa}^{\lambda} \partial^\kappa f_{\alpha\lambda} +$$
$$\frac{1}{6} t_2 \partial^\alpha f_{\kappa}^{\lambda} \partial^\kappa f_{\alpha\lambda} + t_1 \omega_{\kappa\alpha}^{\alpha} \partial^\kappa f_{\prime}^{\prime} + t_1 \omega_{\kappa\lambda}^{\lambda} \partial^\kappa f_{\prime}^{\prime} + 2 t_1 \partial^\alpha f_{\kappa\alpha} \partial^\kappa f_{\prime}^{\prime} -$$
$$t_1 \partial_\kappa f_{\prime}^{\lambda} \partial^\kappa f_{\prime}^{\prime} + \frac{1}{3} t_1 \omega_{\theta\kappa} \partial^\kappa f_{\prime}^{\theta} + \frac{1}{3} t_2 \omega_{\theta\kappa} \partial^\kappa f_{\prime}^{\theta} + \frac{4}{3} t_1 \omega_{\theta\kappa} \partial^\kappa f_{\prime}^{\theta} -$$
$$\frac{2}{3} t_2 \omega_{\theta\kappa} \partial^\kappa f_{\prime}^{\theta} - \frac{1}{3} t_1 \omega_{\theta\kappa} \partial^\kappa f_{\prime}^{\theta} - \frac{1}{3} t_2 \omega_{\theta\kappa} \partial^\kappa f_{\prime}^{\theta} + \frac{2}{3} t_1 \omega_{\theta\kappa} \partial^\kappa f_{\prime}^{\theta} +$$
$$\frac{2}{3} t_2 \omega_{\theta\kappa} \partial^\kappa f_{\prime}^{\theta} - t_1 \omega_{\alpha}^{\alpha} \partial^\kappa f_{\prime}^{\kappa} - t_1 \omega_{\alpha\lambda}^{\lambda} \partial^\kappa f_{\prime}^{\kappa} + \frac{1}{3} t_1 \partial^\alpha f_{\kappa}^{\lambda} \partial^\kappa f_{\lambda\alpha} -$$
$$\frac{1}{6} t_2 \partial^\alpha f_{\kappa}^{\lambda} \partial^\kappa f_{\lambda\alpha} + \frac{1}{3} t_1 \partial_\kappa f_{\theta}^{\lambda} \partial^\kappa f_{\lambda}^{\theta} - \frac{1}{6} t_2 \partial_\kappa f_{\theta}^{\lambda} \partial^\kappa f_{\lambda}^{\theta} + \frac{2}{3} t_1 \partial_\kappa f_{\theta}^{\lambda} \partial^\kappa f_{\lambda}^{\theta} +$$
$$\frac{1}{6} t_2 \partial_\kappa f_{\theta}^{\lambda} \partial^\kappa f_{\lambda}^{\theta} - t_1 \partial^\alpha f_{\lambda\alpha} \partial^\kappa f_{\lambda\kappa} + \frac{2}{3} r_1 \partial_\kappa \omega^{\alpha\beta\theta} \partial^\kappa \omega_{\alpha\beta\theta} - \frac{2}{3} r_1 \partial_\kappa \omega^{\theta\alpha\beta} \partial^\kappa \omega_{\alpha\beta\theta} +$$
$$\frac{2}{3} r_1 \partial^\beta \omega_{\prime}^{\alpha\lambda} \partial_\lambda \omega_{\alpha\beta}^{\prime} - \frac{8}{3} r_1 \partial^\beta \omega_{\prime}^{\lambda\alpha} \partial_\lambda \omega_{\alpha\beta}^{\prime} + r_5 \partial_\alpha \omega_{\lambda\theta}^{\alpha} \partial^\lambda \omega_{\kappa}^{\theta\kappa} - r_5 \partial_\theta \omega_{\lambda\alpha}^{\alpha} \partial^\lambda \omega_{\kappa}^{\theta\kappa}$$

$\omega_{1+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1+}^{\#2}$	$f_{1+}^{\#1}$	$\omega_{1-}^{\#1}$	$\omega_{1-}^{\#2}$	$f_{1-}^{\#1}$	$f_{1-}^{\#2}$
$\frac{1}{6}(6k^2(2r_1+r_5)+t_1+4t_2)$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$-\frac{i k(t_1-2t_2)}{3\sqrt{2}}$	0	0	0	0
$-\frac{t_1-2t_2}{3\sqrt{2}}$	$\frac{t_1+t_2}{3}$	$\frac{1}{3}ik(t_1+t_2)$	0	0	0	0
$\frac{ik(t_1-2t_2)}{3\sqrt{2}}$	$-\frac{1}{3}ik(t_1+t_2)$	$\frac{1}{3}k^2(t_1+t_2)$	0	0	0	0
0	0	0	$k^2(r_1+r_5)-\frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	0	$ik t_1$
0	0	0	$\frac{t_1}{\sqrt{2}}$	0	0	0
0	0	0	0	0	0	0
0	0	0	$-ik t_1$	0	0	0

Massive and massless spectra



Massive particle	
Pole residue:	$\frac{-3t_1t_2(t_1+t_2)+6r_1(t_1^2+2t_2^2)+3r_5(t_1^2+2t_2^2)}{(2r_1+r_5)(t_1+t_2)-(-3t_1t_2+4r_1(t_1+t_2)+2r_5(t_1+t_2))} > 0$
Polarisations:	3
Square mass:	$-\frac{3t_1t_2}{2(2r_1+r_5)(t_1+t_2)} > 0$
Spin:	1
Parity:	Even



Massive particle	
Pole residue:	$-\frac{1}{r_1} > 0$
Polarisations:	5
Square mass:	$-\frac{t_1}{2r_1} > 0$
Spin:	2
Parity:	Odd

(No massless particles)

Unitarity conditions

$r_1 < 0 \ \&\& \ r_5 > -2r_1 \ \&\& \ t_1 > 0 \ \&\& \ -t_1 < t_2 < 0$