

Particle spectrograph

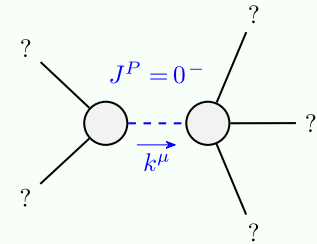
Wave operator and propagator

Quadratic (free) action

$$S_F ==$$
$$\int \int \int \int (\frac{1}{6}(4t_3\omega_{\kappa\alpha}^{\alpha\iota}\omega_{\kappa\alpha}^{\kappa}+4t_2\omega_{\kappa\lambda}^{\kappa\lambda}\omega_{\kappa\lambda}^{\iota}+2t_2\omega_{\kappa\lambda}^{\iota}\omega_{\kappa\lambda}^{\kappa\lambda}+6f^{\alpha\beta}\tau_{\alpha\beta}+6\omega^{\alpha\beta\chi}\sigma_{\alpha\beta\chi}+4r_2\partial^\beta\omega_{\kappa}^{\theta\alpha}\partial_\theta\omega_{\alpha\beta}^{\kappa}-2r_2\partial_\theta\omega_{\alpha\beta}^{\kappa}\partial_\kappa\omega^{\alpha\beta\theta}-4r_2\partial_\theta\omega_{\alpha\beta}^{\kappa}\partial_\kappa\omega^{\theta\alpha\beta}+t_2\partial^\alpha f_{\theta\kappa}\partial^\kappa f_{\alpha}^{\theta}-t_2\partial_2^\alpha f_{\kappa\theta}\partial^\kappa f_{\alpha}^{\theta}+t_2\partial_2^\alpha f_{\lambda}^{\theta}\partial^\kappa f_{\alpha\lambda}-4t_3\omega_{\kappa\lambda}^{\lambda}\partial^\kappa f_{\iota}^{\iota}-8t_3\partial_3^\alpha f_{\kappa\alpha}\partial^\kappa f_{\iota}^{\iota}+4t_3\partial_3\partial_\kappa f_{\lambda}^{\lambda}\partial^\kappa f_{\iota}^{\iota}+2t_2\omega_{\iota\theta\kappa}\partial^\kappa f_{\iota}^{\theta}-4t_2\omega_{\iota\kappa\theta}\partial^\kappa f_{\iota}^{\theta}-2t_2\omega_{\theta\iota\kappa}\partial^\kappa f_{\iota}^{\theta}+4t_2\omega_{\theta\kappa\iota}\partial^\kappa f_{\iota}^{\theta}+4t_3\omega_{\iota\lambda}^{\lambda}\partial^\kappa f_{\iota}^{\theta}-t_2\partial^\alpha f_{\kappa}^{\lambda}\partial^\kappa f_{\lambda\alpha}-t_2\partial_2\partial_\kappa f_{\theta}^{\lambda}\partial^\kappa f_{\lambda}^{\theta}+t_2\partial_2\partial_\kappa f_{\theta}^{\lambda}\partial^\kappa f_{\lambda}^{\theta}+4t_3\partial^\alpha f_{\alpha}^{\lambda}\partial^\kappa f_{\lambda\kappa}+2r_2\partial_\kappa\omega^{\alpha\beta\theta}\partial^\kappa\omega_{\alpha\beta\theta}+4r_2\partial_\kappa\omega^{\theta\alpha\beta}\partial^\kappa\omega_{\alpha\beta\theta}-4r_2\partial^\beta\omega_{\iota}^{\alpha\lambda}\partial_\lambda\omega_{\alpha\beta}^{\iota}+4r_2\partial^\beta\omega_{\iota}^{\lambda\alpha}\partial_\lambda\omega_{\alpha\beta}^{\iota})) [t, x, y, z] dz dy dx dt$$

(no massless particles)

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

Unitarity conditions

$$r_2 < 0 \ \&\& \ t_2 > 0$$

	$\sigma_{1^+}^{\#1} \dagger \alpha\beta$	$\sigma_{1^+}^{\#2} \dagger \alpha\beta$	$\tau_{1^+}^{\#1} \dagger \alpha\beta$	$\sigma_{1^+}^{\#1} \dagger \alpha$	$\sigma_{1^+}^{\#2} \dagger \alpha$	$\tau_{1^+}^{\#1} \dagger \alpha$	$\tau_{1^+}^{\#2} \dagger \alpha$
$\sigma_{1^+}^{\#1} \dagger \alpha\beta$	$\frac{6}{(3+k^2)^2 t_2}$	$\frac{3\sqrt{2}}{(3+k^2)^2 t_2}$	$\frac{3i\sqrt{2}k}{(3+k^2)^2 t_2}$	0	0	0	0
$\sigma_{1^+}^{\#2} \dagger \alpha\beta$	$\frac{3\sqrt{2}}{(3+k^2)^2 t_2}$	$\frac{3}{(3+k^2)^2 t_2}$	$\frac{3ik}{(3+k^2)^2 t_2}$	0	0	0	0
$\tau_{1^+}^{\#1} \dagger \alpha\beta$	$-\frac{3i\sqrt{2}k}{(3+k^2)^2 t_2}$	$-\frac{3ik}{(3+k^2)^2 t_2}$	$\frac{3k^2}{(3+k^2)^2 t_2}$	0	0	0	0
$\sigma_{1^+}^{\#1} \dagger \alpha$	0	0	0	$\frac{6}{(3+2k^2)^2 t_3}$	$-\frac{3\sqrt{2}}{(3+2k^2)^2 t_3}$	0	$-\frac{6ik}{(3+2k^2)^2 t_3}$
$\sigma_{1^+}^{\#2} \dagger \alpha$	0	0	0	$-\frac{3\sqrt{2}}{(3+2k^2)^2 t_3}$	$\frac{3}{(3+2k^2)^2 t_3}$	0	$\frac{3i\sqrt{2}k}{(3+2k^2)^2 t_3}$
$\tau_{1^+}^{\#1} \dagger \alpha$	0	0	0	0	0	0	0
$\tau_{1^+}^{\#2} \dagger \alpha$	0	0	0	$\frac{6ik}{(3+2k^2)^2 t_3}$	$-\frac{3i\sqrt{2}k}{(3+2k^2)^2 t_3}$	0	$\frac{6k^2}{(3+2k^2)^2 t_3}$

	$\omega_{1^+}^{\#1} \dagger \alpha\beta$	$\omega_{1^+}^{\#2} \dagger \alpha\beta$	$f_{1^+}^{\#1} \dagger \alpha\beta$	$\omega_{1^+}^{\#1} \dagger \alpha$	$\omega_{1^+}^{\#2} \dagger \alpha$	$f_{1^+}^{\#1} \dagger \alpha$	$f_{1^+}^{\#2} \dagger \alpha$
$\omega_{1^+}^{\#1} \dagger \alpha\beta$	$\frac{2t_2}{3}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{1}{3}i\sqrt{2}kt_2$	0	0	0	0
$\omega_{1^+}^{\#2} \dagger \alpha\beta$	$\frac{\sqrt{2}t_2}{3}$	$\frac{t_2}{3}$	$\frac{ikt_2}{3}$	0	0	0	0
$f_{1^+}^{\#1} \dagger \alpha\beta$	$-\frac{1}{3}i\sqrt{2}kt_2$	$-\frac{1}{3}ikt_2$	$\frac{k^2t_2}{3}$	0	0	0	0
$\omega_{1^+}^{\#1} \dagger \alpha$	0	0	0	$\frac{2t_3}{3}$	$-\frac{\sqrt{2}t_3}{3}$	0	$-\frac{2}{3}ikt_3$
$\omega_{1^+}^{\#2} \dagger \alpha$	0	0	0	$-\frac{\sqrt{2}t_3}{3}$	$\frac{t_3}{3}$	0	$\frac{1}{3}i\sqrt{2}kt_3$
$f_{1^+}^{\#1} \dagger \alpha$	0	0	0	0	0	0	0
$f_{1^+}^{\#2} \dagger \alpha$	0	0	0	$\frac{2ikt_3}{3}$	$-\frac{1}{3}i\sqrt{2}kt_3$	0	$\frac{2k^2t_3}{3}$

Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau_{0^+}^{\#2} == 0$	1
$\tau_{0^+}^{\#1} - 2ik\sigma_{0^+}^{\#1} == 0$	1
$\tau_{1^+}^{\#2\alpha} - ik\sigma_{1^+}^{\#1\alpha} == 0$	3
$\tau_{1^+}^{\#1\alpha} == 0$	3
$\sigma_{1^+}^{\#1\alpha} + 2\sigma_{1^+}^{\#2\alpha} == 0$	3
$\tau_{1^+}^{\#1\alpha\beta} + ik\sigma_{1^+}^{\#1\alpha\beta} == 0$	3
$\sigma_{1^+}^{\#1\alpha\beta} == \sigma_{1^+}^{\#2\alpha\beta}$	3
$\sigma_{2^+}^{\#1\alpha\beta\chi} == 0$	5
$\tau_{2^+}^{\#1\alpha\beta} == 0$	5
$\sigma_{2^+}^{\#1\alpha\beta} == 0$	5
Total constraints:	32

	$\sigma_{0^+}^{\#1} \dagger$	$\tau_{0^+}^{\#1} \dagger$	$\tau_{0^+}^{\#2} \dagger$	$\sigma_{0^+}^{\#1} \dagger$
$\sigma_{0^+}^{\#1} \dagger$	$\frac{1}{(1+2k^2)^2 t_3}$	$-\frac{i\sqrt{2}k}{(1+2k^2)^2 t_3}$	0	0
$\tau_{0^+}^{\#1} \dagger$	$\frac{i\sqrt{2}k}{(1+2k^2)^2 t_3}$	$\frac{2k^2}{(1+2k^2)^2 t_3}$	0	0
$\tau_{0^+}^{\#2} \dagger$	0	0	0	0
$\sigma_{0^+}^{\#1} \dagger$	0	0	0	$\frac{1}{k^2 r_2 + t_2}$

	$\sigma_{2^+}^{\#1} \dagger \alpha\beta$	$\tau_{2^+}^{\#1} \dagger \alpha\beta$	$\sigma_{2^+}^{\#1} \dagger \alpha\beta\chi$
$\sigma_{2^+}^{\#1} \dagger \alpha\beta$	0	0	0
$\tau_{2^+}^{\#1} \dagger \alpha\beta$	0	0	0
$\sigma_{2^+}^{\#1} \dagger \alpha\beta\chi$	0	0	0

	$\omega_{0^+}^{\#1} \dagger$	$f_{0^+}^{\#1} \dagger$	$f_{0^+}^{\#2} \dagger$	$\omega_{0^+}^{\#1} \dagger$
$\omega_{0^+}^{\#1} \dagger$	t_3	$-i\sqrt{2}kt_3$	0	0
$f_{0^+}^{\#1} \dagger$	$i\sqrt{2}kt_3$	$2k^2t_3$	0	0
$f_{0^+}^{\#2} \dagger$	0	0	0	0
$\omega_{0^+}^{\#1} \dagger$	0	0	0	$k^2 r_2 + t_2$

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