

Particle spectrograph

Wave operator and propagator

Quadratic (free) action

$$S = \iiint (\omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - \frac{2}{3} r_1 (2 \partial_\beta \omega_{\alpha i \theta} - \partial_\beta \omega_{\alpha \theta i} + 4 \partial_\beta \omega_{i \theta \alpha} + \partial_i \omega_{\alpha \beta \theta} - \partial_\theta \omega_{\alpha \beta i} - \partial_\theta \omega_{\alpha i \beta}) \partial^\theta \omega^{\alpha\beta i} + r_5 (\partial_i \omega_{\theta \kappa}^\kappa \partial^\theta \omega_{\alpha}^{\alpha i} - \partial_\theta \omega_{i \kappa}^\kappa \partial^\theta \omega_{\alpha}^{\alpha i} - (\partial_\alpha \omega^{\alpha i \theta} - 2 \partial^\theta \omega_{\alpha}^{\alpha i}) (\partial_\kappa \omega_{i \theta}^\kappa - \partial_\kappa \omega_{\theta i}^\kappa))) [t, x, y, z] dz dy dx dt$$

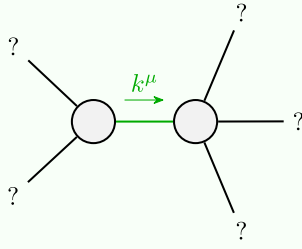
$$\begin{matrix} & \sigma_{2+}^{\#1}{}_{\alpha\beta} & \sigma_{2-}^{\#1}{}_{\alpha\beta\chi} \\ \sigma_{2+}^{\#1}{}_{\dagger\alpha\beta} & 0 & 0 \\ \sigma_{2-}^{\#1}{}_{\dagger\alpha\beta\chi} & 0 & \frac{1}{k^2 r_1} \end{matrix}$$
$$\begin{matrix} & \omega_{0+}^{\#1} & \omega_{0-}^{\#1} \\ \omega_{0+}^{\#1}{}_{\dagger} & 0 & 0 \\ \omega_{0-}^{\#1}{}_{\dagger} & 0 & 0 \end{matrix}$$
$$\begin{matrix} & \sigma_{0+}^{\#1} & \sigma_{0-}^{\#1} \\ \sigma_{0+}^{\#1}{}_{\dagger} & 0 & 0 \\ \sigma_{0-}^{\#1}{}_{\dagger} & 0 & 0 \end{matrix}$$

$$\begin{matrix} & \sigma_{1+}^{\#1}{}_{\alpha\beta} & \sigma_{1+}^{\#2}{}_{\alpha\beta} & \sigma_{1-}^{\#1}{}_{\alpha} & \sigma_{1-}^{\#2}{}_{\alpha} \\ \sigma_{1+}^{\#1}{}_{\dagger\alpha\beta} & \frac{1}{k^2 (2r_1+r_5)} & 0 & 0 & 0 \\ \sigma_{1+}^{\#2}{}_{\dagger\alpha\beta} & 0 & 0 & 0 & 0 \\ \sigma_{1-}^{\#1}{}_{\dagger\alpha} & 0 & 0 & \frac{1}{k^2 (r_1+r_5)} & 0 \\ \sigma_{1-}^{\#2}{}_{\dagger\alpha} & 0 & 0 & 0 & 0 \end{matrix}$$
$$\begin{matrix} & \omega_{2+}^{\#1}{}_{\alpha\beta} & \omega_{2-}^{\#1}{}_{\alpha\beta\chi} \\ \omega_{2+}^{\#1}{}_{\dagger\alpha\beta} & 0 & 0 \\ \omega_{2-}^{\#1}{}_{\dagger\alpha\beta\chi} & 0 & k^2 r_1 \end{matrix}$$
$$\begin{matrix} & \omega_{1-}^{\#2}{}_{\alpha} & \omega_{1-}^{\#1}{}_{\alpha} & \omega_{1+}^{\#2}{}_{\alpha\beta} & \omega_{1+}^{\#1}{}_{\alpha\beta} \\ \omega_{1+}^{\#1}{}_{\dagger\alpha\beta} & k^2 (2r_1+r_5) & 0 & 0 & 0 \\ \omega_{1+}^{\#2}{}_{\dagger\alpha\beta} & 0 & 0 & 0 & 0 \\ \omega_{1-}^{\#1}{}_{\dagger\alpha} & 0 & 0 & k^2 (r_1+r_5) & 0 \\ \omega_{1-}^{\#2}{}_{\dagger\alpha} & 0 & 0 & 0 & 0 \end{matrix}$$

Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\sigma_{0-}^{\#1} == 0$	1
$\sigma_{0+}^{\#1} == 0$	1
$\sigma_{1-}^{\#2\alpha} == 0$	3
$\sigma_{1+}^{\#2\alpha\beta} == 0$	3
$\sigma_{2+}^{\#1\alpha\beta} == 0$	5
Total constraints:	13

Massive and massless spectra



Quadratic pole

Pole residue:	$-\frac{1}{r_1 (r_1+r_5) (2r_1+r_5)} > 0$
Polarisations:	2

(No massive particles)

Unitarity conditions

$$r_1 < 0 \&\& (r_5 < -r_1 || r_5 > -2r_1) || r_1 > 0 \&\& -2r_1 < r_5 < -r_1$$