

Particle spectrograph

Wave operator and propagator

$\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1+}^{\#2} \alpha\beta$	$\tau_{1+}^{\#1} \alpha\beta$	$\sigma_{1-}^{\#1} \alpha$	$\sigma_{1-}^{\#2} \alpha$	$\tau_{1-}^{\#1} \alpha$	$\tau_{1-}^{\#2} \alpha$
$\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$	0	$\frac{2\sqrt{2}}{(\alpha_0-4\beta_1)(1+k^2)}$	0	0	0	0
$\sigma_{1+}^{\#2} \dagger^{\alpha\beta}$	$\frac{2\sqrt{2}}{(\alpha_0-4\beta_1)(1+k^2)}$	$-\frac{2}{(\alpha_0-4\beta_1)(1+k^2)^2}$	0	0	0	0
$\tau_{1+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{2i\sqrt{2}k}{(\alpha_0-4\beta_1)(1+k^2)}$	$-\frac{2ik}{(\alpha_0-4\beta_1)(1+k^2)^2}$	0	0	0	0
$\sigma_{1-}^{\#1} \dagger^\alpha$	0	0	0	$-\frac{2\sqrt{2}}{(\alpha_0-4\beta_1)(1+2k^2)}$	0	$-\frac{4ik}{(\alpha_0-4\beta_1)(1+2k^2)}$
$\sigma_{1-}^{\#2} \dagger^\alpha$	0	0	$-\frac{2\sqrt{2}}{(\alpha_0-4\beta_1)(1+2k^2)}$	0	0	$-\frac{2i\sqrt{2}k}{(\alpha_0-4\beta_1)(1+2k^2)^2}$
$\tau_{1-}^{\#1} \dagger^\alpha$	0	0	0	0	0	0
$\tau_{1-}^{\#2} \dagger^\alpha$	0	0	$\frac{4ik}{(\alpha_0-4\beta_1)(1+2k^2)}$	0	0	$-\frac{4k^2}{(\alpha_0-4\beta_1)(1+2k^2)^2}$

Quadratic (free) action

$$S = \iiint (f^{\alpha\beta} \tau_{\alpha\beta} + \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - \frac{1}{2} \alpha_0 (\omega_{\alpha\chi\beta} \omega^{\alpha\beta\chi} + \omega_\alpha^{\alpha\beta} \omega_\beta^{\alpha\beta} \omega_\chi^{\alpha\beta} + 2 f_\alpha^{\alpha\beta} \partial_\beta \omega_\alpha^{\chi\beta} - 2 \partial_\beta \omega_\alpha^{\alpha\beta} - 2 f_\alpha^{\alpha\beta} \partial_\chi \omega_\alpha^{\chi\beta} + 2 f_\alpha^{\alpha\beta} \partial_\chi \omega_\beta^{\beta\chi}) + \beta_1 (2 \omega_\alpha^{\alpha\beta} \omega_\beta^{\chi\alpha} - 4 \omega_\alpha^{\chi\alpha} \omega_\beta^{\alpha\beta} + 4 \omega_\beta^{\chi\alpha} \partial_\beta f_\alpha^{\alpha\beta} - 2 \partial_\beta f_\alpha^{\chi\alpha} \partial_\beta f_\alpha^{\alpha\beta} - 2 \partial_\beta f_\alpha^{\alpha\beta} \partial_\chi f_\alpha^{\chi\alpha} + 4 \partial_\beta f_\alpha^{\alpha\beta} \partial_\chi f_\beta^{\chi\alpha} - 2 \partial_\alpha f_{\beta\chi} \partial^\chi f^{\alpha\beta} - \partial_\alpha f_{\chi\beta} \partial^\chi f^{\alpha\beta} + \partial_\beta f_{\alpha\chi} \partial^\chi f^{\alpha\beta} + \partial_\chi f_{\alpha\beta} \partial^\alpha f^{\alpha\beta} + \partial_\chi f^{\alpha\beta} + \partial_\chi f_{\beta\alpha} \partial^\alpha f^{\alpha\beta} + 2 \omega_{\alpha\chi\beta} (\omega^{\alpha\beta\chi} + 2 \partial^\chi f^{\alpha\beta})) + \frac{1}{3} \alpha_3 (4 \partial_\beta \omega_{\alpha\chi\delta} - 2 \partial_\beta \omega_{\alpha\delta\chi} + 2 \partial_\beta \omega_{\chi\delta\alpha} - \partial_\chi \omega_{\alpha\beta\delta} + \partial_\delta \omega_{\alpha\beta\chi} - 2 \partial_\delta \omega_{\alpha\chi\beta}) \partial^\delta \omega^{\alpha\beta\chi}) [t, x, y, z] dz dy dx dt$$

	$\omega_{0+}^{\#1}$	$f_{0+}^{\#1}$	$f_{0+}^{\#2}$	$\omega_{0-}^{\#1}$
$\omega_{0+}^{\#1} \dagger$	$\frac{1}{2} (\alpha_0 - 4 \beta_1)$	$-\frac{i (\alpha_0 - 4 \beta_1) k}{\sqrt{2}}$	0	0
$f_{0+}^{\#1} \dagger$	$\frac{i (\alpha_0 - 4 \beta_1) k}{\sqrt{2}}$	$-4 \beta_1 k^2$	0	0
$f_{0+}^{\#2} \dagger$	0	0	0	0
$\omega_{0-}^{\#1} \dagger$	0	0	0	$\frac{\alpha_0}{2} - 2 \beta_1 + \alpha_3 k^2$

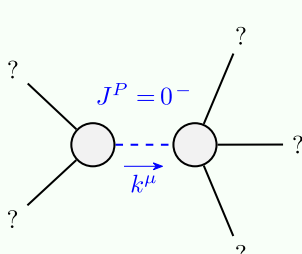
Source constraints	Fundamental fields	Multiplicities
$SO(3)$ irreps		
$\tau_{0+}^{\#2} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == 0$	1
$\tau_{1-}^{\#2\alpha} + 2 i k \sigma_{1-}^{\#2\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta} + 2 \partial_\delta \partial^\delta \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi}$	3
$\tau_{1-}^{\#1\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\beta\alpha}$	3
$\tau_{1+}^{\#1\alpha\beta} + i k \sigma_{1+}^{\#2\alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial_\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} + 2 \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} == \partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial_\beta \tau^{\alpha\chi} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\chi \tau^{\beta\alpha} + 2 \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi}$	3
Total constraints/gauge generators:		10

	$\omega_{2+}^{\#1} \alpha\beta$	$f_{2+}^{\#1} \alpha\beta$	$\omega_{2-}^{\#1} \alpha\beta\chi$
$\omega_{2+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{\alpha_0}{4} + \beta_1$	$\frac{i (\alpha_0 - 4 \beta_1) k}{2 \sqrt{2}}$	0
$f_{2+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{i (\alpha_0 - 4 \beta_1) k}{2 \sqrt{2}}$	$2 \beta_1 k^2$	0
$\omega_{2-}^{\#1} \dagger^{\alpha\beta\chi}$	0	0	$-\frac{\alpha_0}{4} + \beta_1$

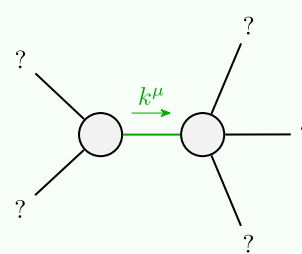
$\omega_{1+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1+}^{\#2} \alpha\beta$	$f_{1+}^{\#1} \alpha\beta$	$\omega_{1-}^{\#1} \alpha$	$\omega_{1-}^{\#2} \alpha$	$f_{1-}^{\#1} \alpha$	$f_{1-}^{\#2} \alpha$
$\omega_{1+}^{\#1} \dagger^{\alpha\beta}$	$\frac{1}{4} (\alpha_0 - 4 \beta_1)$	$\frac{i (\alpha_0 - 4 \beta_1) k}{2 \sqrt{2}}$	0	0	0	0
$\omega_{1+}^{\#2} \dagger^{\alpha\beta}$	$\frac{\alpha_0 - 4 \beta_1}{2 \sqrt{2}}$	0	0	0	0	0
$f_{1+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{i (\alpha_0 - 4 \beta_1) k}{2 \sqrt{2}}$	0	0	0	0	0
$\omega_{1-}^{\#1} \dagger^\alpha$	0	0	$\frac{1}{4} (\alpha_0 - 4 \beta_1)$	$-\frac{\alpha_0 - 4 \beta_1}{2 \sqrt{2}}$	0	$-\frac{1}{2} i (\alpha_0 - 4 \beta_1) k$
$\omega_{1-}^{\#2} \dagger^\alpha$	0	0	$-\frac{\alpha_0 - 4 \beta_1}{2 \sqrt{2}}$	0	0	0
$f_{1-}^{\#1} \dagger^\alpha$	0	0	0	0	0	0
$f_{1-}^{\#2} \dagger^\alpha$	0	0	$\frac{1}{2} i (\alpha_0 - 4 \beta_1) k$	0	0	0

$\sigma_{2+}^{\#1} \dagger^{\alpha\beta}$	$\tau_{2+}^{\#1} \alpha\beta$	$\sigma_{2-}^{\#1} \alpha\beta\chi$
$\sigma_{2+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{16 \beta_1}{\alpha_0^2 - 4 \alpha_0 \beta_1}$	0
$\tau_{2+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{2 i \sqrt{2}}{\alpha_0 k}$	0
$\sigma_{2-}^{\#1} \dagger^{\alpha\beta\chi}$	0	$\frac{1}{-\alpha_0 + \beta_1}$

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{\alpha_3} > 0$
Polarisations:	1
Square mass:	$-\frac{\alpha_0 - 4 \beta_1}{2 \alpha_3} > 0$
Spin:	0
Parity:	Odd



Quadratic pole	
Pole residue:	$\frac{1}{\alpha_0} > 0$
Polarisations:	2

Unitarity conditions

$$\alpha_0 > 0 \ \&\& \ \alpha_3 < 0 \ \&\& \ \beta_1 < \frac{\alpha_0}{4}$$