

Particle spectrograph

Wave operator and propagator

$\sigma_1^{#1} \dagger^{\alpha\beta}$	$\sigma_1^{#2} \dagger^{\alpha\beta}$	$\tau_1^{#1} \dagger^{\alpha\beta}$	$\sigma_1^{#1-} \alpha$	$\sigma_1^{#2-} \alpha$	$\tau_1^{#1-} \alpha$	$\tau_1^{#2-} \alpha$
0	$\frac{2\sqrt{2}}{(\alpha_0-4\beta_1)(1+k^2)}$	$-\frac{2i\sqrt{2}k}{(\alpha_0-4\beta_1)(1+k^2)^2}$	0	0	0	0
$\frac{2\sqrt{2}}{(\alpha_0-4\beta_1)(1+k^2)}$	$-\frac{2i\sqrt{2}k}{(\alpha_0-4\beta_1)(1+k^2)^2}$	$-\frac{2ik}{(\alpha_0-4\beta_1)(1+k^2)^2}$	0	0	0	0
$-\frac{2i\sqrt{2}k}{(\alpha_0-4\beta_1)(1+k^2)^2}$	$-\frac{2ik}{(\alpha_0-4\beta_1)(1+k^2)^2}$	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

$\omega_0^{#1} \dagger^{\alpha\beta}$	$f_0^{#1} \dagger^{\alpha\beta}$	$f_0^{#2} \dagger^{\alpha\beta}$	$\omega_0^{#1-} \alpha$
$\frac{1}{2}(\alpha_0-4\beta_1)$	$-\frac{i(\alpha_0-4\beta_1)k}{\sqrt{2}}$	0	0
$\frac{i(\alpha_0-4\beta_1)k}{\sqrt{2}}$	$-4\beta_1 k^2$	0	0
0	0	0	0
0	0	0	$\frac{\alpha_0}{2}-2\beta_1+\alpha_3 k^2$

$\sigma_2^{#1} \dagger^{\alpha\beta}$	$\tau_2^{#1} \dagger^{\alpha\beta}$	$\sigma_2^{#1-} \alpha\beta\chi$
$-\frac{16\beta_1}{\alpha_0^2-4\alpha_0\beta_1}$	$-\frac{2i\sqrt{2}}{\alpha_0 k}$	0
0	$\frac{2}{\alpha_0 k^2}$	0
0	0	$\frac{1}{\alpha_0+4\beta_1}$

$\omega_2^{#1} \dagger^{\alpha\beta}$	$f_2^{#1} \dagger^{\alpha\beta}$	$\omega_2^{#1-} \alpha\beta\chi$
$-\frac{\alpha_0}{4}+\beta_1$	$\frac{i(\alpha_0-4\beta_1)k}{2\sqrt{2}}$	0
$-\frac{i(\alpha_0-4\beta_1)k}{2\sqrt{2}}$	$2\beta_1 k^2$	0
0	0	$-\frac{\alpha_0}{4}+\beta_1$

$\omega_1^{#1} \dagger^{\alpha\beta}$	$\omega_1^{#2} \dagger^{\alpha\beta}$	$f_1^{#1} \dagger^{\alpha\beta}$	$\omega_1^{#1-} \alpha$	$\omega_1^{#2-} \alpha$	$f_1^{#1-} \alpha$	$f_1^{#2-} \alpha$
$\frac{1}{4}(\alpha_0-4\beta_1)$	$\frac{\alpha_0-4\beta_1}{2\sqrt{2}}$	$\frac{i(\alpha_0-4\beta_1)k}{2\sqrt{2}}$	0	0	0	0
$\frac{\alpha_0-4\beta_1}{2\sqrt{2}}$	0	0	0	0	0	0
$-\frac{i(\alpha_0-4\beta_1)k}{2\sqrt{2}}$	0	0	$\frac{1}{4}(\alpha_0-4\beta_1)$	$-\frac{\alpha_0-4\beta_1}{2\sqrt{2}}$	$-\frac{1}{2}i(\alpha_0-4\beta_1)k$	0
0	0	0	$-\frac{\alpha_0-4\beta_1}{2\sqrt{2}}$	0	0	0
0	0	0	0	0	0	0
0	0	0	$\frac{1}{2}i(\alpha_0-4\beta_1)k$	0	0	0

Source constraints/gauge generators	
SO(3) irreps	Multiplicities
$\tau_0^{#2} == 0$	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
Total constraints:	10

$\sigma_0^{#1} \dagger^{\alpha\beta}$	$\tau_0^{#1} \dagger^{\alpha\beta}$	$\tau_0^{#2} \dagger^{\alpha\beta}$	$\sigma_0^{#1-} \alpha$
$\frac{8\beta_1}{\alpha_0^2-4\alpha_0\beta_1}$	$-\frac{i\sqrt{2}}{\alpha_0 k}$	0	0
$\frac{i\sqrt{2}}{\alpha_0 k}$	$-\frac{1}{\alpha_0 k^2}$	0	0
0	0	0	$\frac{2}{\alpha_0-4\beta_1+2\alpha_3 k^2}$

Quadratic (free) action

$$S = \iiint \int (f^{\alpha\beta} \tau_{\alpha\beta} + \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - \frac{1}{2} \alpha_0 (\omega_{\alpha\chi\beta} \omega^{\alpha\beta\chi} + \omega^{\alpha\beta}_{\alpha} \omega_{\beta}^{\chi} + 2 f^{\alpha\beta} \partial_{\beta} \omega_{\alpha}^{\chi} - 2 \partial_{\beta} \omega^{\alpha\beta}_{\alpha} - 2 f^{\alpha\beta} \partial_{\chi} \omega_{\alpha}^{\chi} + 2 f^{\alpha}_{\alpha} \partial_{\chi} \omega^{\beta\chi}_{\beta}) +$$

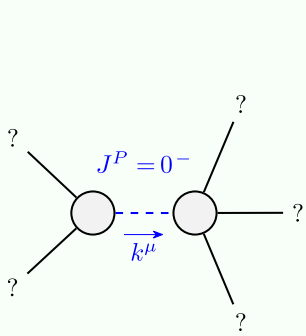
$$\beta_1 (2 \omega^{\alpha\beta}_{\alpha} \omega_{\beta}^{\chi} - 4 \omega_{\alpha}^{\chi} \partial_{\beta} f^{\alpha\beta} + 4 \omega_{\beta}^{\chi} \partial^{\beta} f^{\alpha}_{\alpha} - 2 \partial_{\beta} f^{\chi}_{\chi} \partial^{\beta} f^{\alpha}_{\alpha} - 2 \partial_{\beta} f^{\alpha\beta} \partial_{\chi} f^{\chi}_{\alpha} + 4 \partial^{\beta} f^{\alpha}_{\alpha} \partial_{\chi} f^{\chi}_{\beta} - 2 \partial_{\alpha} f_{\beta\chi} \partial^{\chi} f^{\alpha\beta} - \partial_{\alpha} f_{\chi\beta} \partial^{\chi} f^{\alpha\beta} +$$

$$\partial_{\beta} f_{\alpha\chi} \partial^{\chi} f^{\alpha\beta} + \partial_{\chi} f_{\alpha\beta} \partial^{\chi} f^{\alpha\beta} + \partial_{\chi} f_{\beta\alpha} \partial^{\chi} f^{\alpha\beta} + 2 \omega_{\alpha\chi\beta} (\omega^{\alpha\beta\chi} + 2 \partial^{\chi} f^{\alpha\beta})) +$$

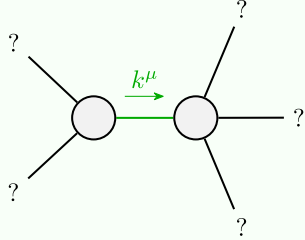
$$\frac{1}{3} \alpha_3 (4 \partial_{\beta} \omega_{\alpha\chi\delta} - 2 \partial_{\beta} \omega_{\alpha\delta\chi} + 2 \partial_{\beta} \omega_{\chi\delta\alpha} - \partial_{\chi} \omega_{\alpha\beta\delta} + \partial_{\delta} \omega_{\alpha\beta\chi} - 2 \partial_{\delta} \omega_{\alpha\chi\beta})$$

$$\partial^{\delta} \omega^{\alpha\beta\chi}) [t, x, y, z] dz dy dx dt$$

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

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