

Particle spectrograph

Wave operator and propagator

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

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

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

	$\sigma_{0+}^{\#1}$	$\tau_{0+}^{\#1}$	$\tau_{0+}^{\#2}$	$\sigma_{0+}^{\#1}$
$\sigma_{0+}^{\#1} \dagger$	$\frac{8\beta_1}{\alpha_0^2-4\alpha_0\beta_1}$	$-\frac{i\sqrt{2}}{\alpha_0 k}$	0	0
$\tau_{0+}^{\#1} \dagger$	$\frac{i\sqrt{2}}{\alpha_0 k}$	$-\frac{1}{\alpha_0 k^2}$	0	0
$\tau_{0+}^{\#2} \dagger$	0	0	0	0
$\sigma_{0+}^{\#1} \dagger$	0	0	0	$\frac{2}{\alpha_0-4\beta_1+2\alpha_3 k^2}$

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

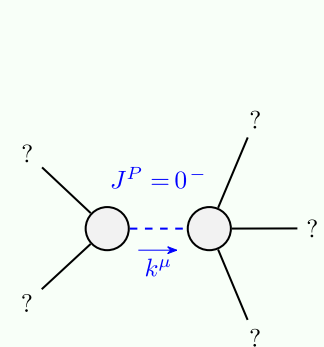
Source constraints/gauge generators	
SO(3) irreps	Multiplicities
$\tau_{0+}^{\#2} == 0$	1
$\tau_{1+}^{\#2\alpha} + 2ik \sigma_{1+}^{\#2\alpha} == 0$	3
$\tau_{1+}^{\#1\alpha} == 0$	3
$\tau_{1+}^{\#1\alpha\beta} + ik \sigma_{1+}^{\#2\alpha\beta} == 0$	3
Total constraints:	10

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

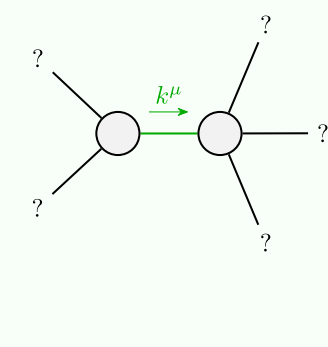
Quadratic (free) action

$$S_F = \iiint \left(-\frac{1}{2}(\alpha_0-4\beta_1) \omega^{\alpha\beta}_{\alpha} \omega^{\chi}_{\beta\chi} + \omega_{\alpha\chi\beta} \left(-\frac{1}{2}\alpha_0 \omega^{\alpha\beta\chi} + 4\beta_1 \partial^{\chi} f^{\alpha\beta} \right) + \right. \\
\frac{1}{3}(-6\beta_1 \omega^{\chi\delta}_{\alpha} \omega^{\alpha}_{\chi\delta} + 3\omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - 6\beta_1 \omega^{\chi}_{\alpha\chi} \partial_{\beta} f^{\alpha\beta} - 6\beta_1 \omega^{\delta}_{\alpha\delta} \partial_{\beta} f^{\alpha\beta} + \\
3\alpha_0 \partial_{\beta} \omega^{\alpha\beta}_{\alpha} + 2\alpha_3 \partial^{\alpha} \omega^{\beta\zeta}_{\chi} \partial_{\beta} \omega^{\chi}_{\zeta\alpha} + 6\beta_1 \omega^{\chi}_{\beta\chi} \partial^{\beta} f^{\alpha}_{\alpha} + 6\beta_1 \omega^{\delta}_{\beta\delta} \partial^{\beta} f^{\alpha}_{\alpha} - \\
6\beta_1 \partial_{\beta} f^{\chi}_{\chi} \partial^{\beta} f^{\alpha}_{\alpha} + 3f^{\alpha\beta} (\tau_{\alpha\beta} - \alpha_0 \partial_{\beta} \omega^{\chi}_{\alpha\chi} + \alpha_0 \partial_{\chi} \omega^{\chi}_{\alpha\beta}) - 3\alpha_0 f^{\alpha}_{\alpha} \partial_{\chi} \omega^{\beta\chi}_{\beta} - \\
2\alpha_3 \partial_{\beta} \omega^{\chi}_{\zeta\alpha} \partial_{\chi} \omega^{\beta\zeta\alpha} - \alpha_3 \partial_{\beta} \omega^{\chi}_{\zeta\alpha} \partial_{\chi} \omega^{\zeta\alpha\beta} + 3\beta_1 \partial_{\chi} f^{\delta}_{\beta} \partial^{\chi} f^{\beta}_{\delta} + 3\beta_1 \partial_{\chi} f^{\delta}_{\beta} \partial^{\chi} f^{\beta}_{\delta} + \\
2\alpha_3 \partial_{\chi} \omega^{\beta\zeta\alpha} \partial^{\chi} \omega^{\zeta\alpha\beta} + \alpha_3 \partial_{\chi} \omega^{\zeta\alpha\beta} \partial^{\chi} \omega^{\zeta\alpha\beta} + 12\beta_1 \partial^{\beta} f^{\alpha}_{\alpha} \partial_{\delta} f^{\delta}_{\beta} - \\
6\beta_1 \partial_{\beta} f^{\beta}_{\chi} \partial_{\delta} f^{\chi\delta} + 2\alpha_3 \partial^{\beta} \omega^{\delta\zeta}_{\alpha} \partial_{\delta} \omega^{\alpha}_{\zeta\beta} - 2\alpha_3 \partial^{\beta} \omega^{\zeta\delta}_{\alpha} \partial_{\delta} \omega^{\alpha}_{\zeta\beta} - 3\beta_1 \partial^{\chi} f^{\beta}_{\zeta} \partial^{\zeta} f^{\beta}_{\beta\chi} - \\
\left. 3\beta_1 \partial^{\chi} f^{\beta}_{\zeta} \partial^{\zeta} f^{\beta}_{\chi\beta} + 3\beta_1 \partial^{\chi} f^{\delta}_{\zeta} \partial^{\zeta} f^{\delta}_{\chi} - 3\beta_1 \partial^{\chi} f^{\delta}_{\zeta} \partial^{\zeta} f^{\delta}_{\chi} \right) [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

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