

Particle spectrograph

Wave operator and propagator

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

	$\mathcal{A}_{0+}^{\#1}$	$f_{0+}^{\#1}$	$f_{0+}^{\#2}$	$\mathcal{A}_{0-}^{\#1}$
$\mathcal{A}_{0+}^{\#1} \dagger$	$\frac{1}{2}(\alpha_0-4\beta_1)$	$-\frac{i(\alpha_0-4\beta_1)k}{\sqrt{2}}$	0	0
$f_{0+}^{\#1} \dagger$	$\frac{i(\alpha_0-4\beta_1)k}{\sqrt{2}}$	$-4\beta_1k^2$	0	0
$f_{0+}^{\#2} \dagger$	0	0	0	0
$\mathcal{A}_{0-}^{\#1} \dagger$	0	0	0	$\frac{\alpha_0}{2}-2\beta_1+\alpha_3k^2$

	$\sigma_{0+}^{\#1}$	$\tau_{0+}^{\#1}$	$\tau_{0+}^{\#2}$	$\sigma_{0-}^{\#1}$
$\sigma_{0+}^{\#1} \dagger$	$\frac{8\beta_1}{\alpha_0^2-4\alpha_0\beta_1}$	$-\frac{i\sqrt{2}}{\alpha_0k}$	0	0
$\tau_{0+}^{\#1} \dagger$	$\frac{i\sqrt{2}}{\alpha_0k}$	$-\frac{1}{\alpha_0k^2}$	0	0
$\tau_{0+}^{\#2} \dagger$	0	0	0	0
$\sigma_{0-}^{\#1} \dagger$	0	0	0	$\frac{2}{\alpha_0-4\beta_1+2\alpha_3k^2}$

	$\mathcal{A}_{2+}^{\#1} \alpha\beta$	$f_{2+}^{\#1} \alpha\beta$	$\mathcal{A}_{2-}^{\#1} \alpha\beta_X$
$\mathcal{A}_{2+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{\alpha_0}{4}+\beta_1$	$\frac{i(\alpha_0-4\beta_1)k}{2\sqrt{2}}$	0
$f_{2+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{i(\alpha_0-4\beta_1)k}{2\sqrt{2}}$	$2\beta_1k^2$	0
$\mathcal{A}_{2-}^{\#1} \dagger^{\alpha\beta_X}$	0	0	$-\frac{\alpha_0}{4}+\beta_1$

Quadratic (free) action

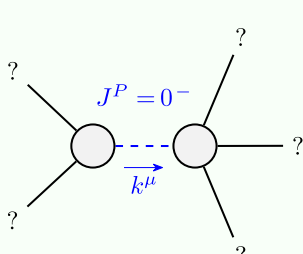
$$S = \iiint (f^{\alpha\beta} \tau_{\alpha\beta} + \mathcal{A}^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - \frac{1}{2} \alpha_0 (\mathcal{A}_{\alpha\chi\beta} \mathcal{A}^{\alpha\beta\chi} + \mathcal{A}_{\beta\chi\alpha}^{\alpha\beta} \mathcal{A}^{\alpha\beta\chi} + 2 f_{\alpha}^{\alpha\beta} \partial_{\beta} \mathcal{A}_{\alpha\chi}^{\chi} - 2 \partial_{\beta} \mathcal{A}_{\alpha}^{\alpha\beta} - 2 f_{\alpha}^{\alpha\beta} \partial_{\chi} \mathcal{A}_{\alpha\beta}^{\chi} + 2 f_{\alpha}^{\alpha} \partial_{\chi} \mathcal{A}_{\beta}^{\beta\chi}) + \beta_1 (2 \mathcal{A}_{\alpha}^{\alpha\beta} \mathcal{A}_{\beta\chi}^{\chi} - 4 \mathcal{A}_{\alpha\chi}^{\chi} \partial_{\beta} f^{\alpha\beta} + 4 \mathcal{A}_{\beta\chi}^{\chi} \partial^{\beta} f_{\alpha}^{\alpha} - 2 \partial_{\beta} f_{\chi}^{\alpha} \partial^{\beta} f_{\alpha}^{\alpha} - 2 \partial_{\beta} f^{\alpha\beta} \partial_{\chi}^{\chi} + 4 \partial^{\beta} f_{\alpha}^{\alpha} \partial_{\chi} f_{\beta}^{\chi} - 2 \partial_{\alpha} f_{\beta\chi} \partial^{\chi} f^{\alpha\beta} - \partial_{\alpha} f_{\chi\beta} \partial^{\beta} f^{\alpha\beta} + \partial_{\beta} f_{\alpha\chi} \partial^{\chi} f^{\alpha\beta} + \partial_{\chi} f^{\alpha\beta} + \partial_{\chi} f^{\alpha\beta}) + \frac{1}{3} \alpha_3 (4 \partial_{\beta} \mathcal{A}_{\alpha\chi\delta} - 2 \partial_{\beta} \mathcal{A}_{\alpha\delta\chi} + 2 \partial_{\beta} \mathcal{A}_{\chi\delta\alpha} - \partial_{\chi} \mathcal{A}_{\alpha\beta\delta} + \partial_{\delta} \mathcal{A}_{\alpha\beta\chi} - 2 \partial_{\delta} \mathcal{A}_{\alpha\chi\beta}) \partial^{\delta} \mathcal{A}^{\alpha\beta\chi}) [t, x, y, z] d t d x d y d z$$

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

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

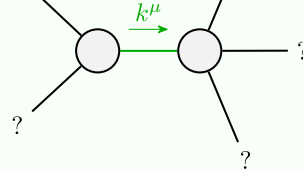
$\sigma_{2+}^{\#1} \dagger^{\alpha\beta}$	$\tau_{2+}^{\#1} \alpha\beta$	$\sigma_{2-}^{\#1} \alpha\beta_X$
$-\frac{16\beta_1}{\alpha_0^2-4\alpha_0\beta_1}$	$\frac{2i\sqrt{2}}{\alpha_0k}$	0
$-\frac{2i\sqrt{2}}{\alpha_0k}$	$\frac{2}{\alpha_0k^2}$	0
0	0	$\frac{1}{-\alpha_0+\beta_1}$

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

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