Particle spectrograph

Wave operator and propagator

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

	$\sigma^{\#1}_{0^{+}}$	$\tau^{\#1}_{0^{+}}$	$\tau^{\#2}_{0^{+}}$	$\sigma^{\#1}_{0^{-}}$
$\sigma^{\#1}_{0^{+}}\dagger$	$\frac{8\beta_1}{\alpha_0^2-4\alpha_0\beta_1+8\alpha_6\beta_1 k^2}$	$-\frac{i\sqrt{2}(\alpha_0-4\beta_1)}{\alpha_0(\alpha_0-4\beta_1)k+8\alpha_6\beta_1 k^3}$	0	0
$\tau^{\#1}_{0^{+}}\dagger$	$\frac{i\sqrt{2}(\alpha_0-4\beta_1)}{\alpha_0(\alpha_0-4\beta_1)k+8\alpha_6\beta_1 k^3}$	$-\frac{\alpha_0-4\beta_1+2\alpha_6 k^2}{k^2(\alpha_0^2-4\alpha_0\beta_1+8\alpha_6\beta_1 k^2)}$	0	0
$\tau^{\#2}_{0^{+}}\dagger$	0	0	0	0
$\sigma^{\#1}_{0^{-}}\dagger$	0	0	0	$\frac{2}{\alpha_0-4\beta_1}$

	$\omega^{\#1}_{0^{+}}$	$f^{\#1}_{0^{+}}$	$f^{\#2}_{0^{+}}$	$\omega^{\#1}_{0^{-}}$
$\omega^{\#1}_{0^{+}}\dagger$	$\frac{\alpha_0}{2}-2\beta_1+\alpha_6 k^2$	$-\frac{i(\alpha_0-4\beta_1)k}{\sqrt{2}}$	0	0
$f^{\#1}_{0^{+}}\dagger$	$\frac{i(\alpha_0-4\beta_1)k}{\sqrt{2}}$	$-4\beta_1 k^2$	0	0
$f^{\#2}_{0^{+}}\dagger$	0	0	0	0
$\omega^{\#1}_{0^{-}}\dagger$	0	0	0	$\frac{1}{2}(\alpha_0-4\beta_1)$

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

Source constraints/gauge generators	
SO(3) irreps	Multiplicities
$\tau^{\#2}_{0^{+}} == 0$	1
$\tau^{\#2}_{1^{-}}{}^{\alpha} + 2 i k \, \sigma^{\#2}_{1^{-}}{}^{\alpha} == 0$	3
$\tau^{\#1}_{1^{-}}{}^{\alpha} == 0$	3
$\tau^{\#1}_{1^{+}}{}^{\alpha\beta} + i k \, \sigma^{\#2}_{1^{+}}{}^{\alpha\beta} == 0$	3
Total constraints:	10

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

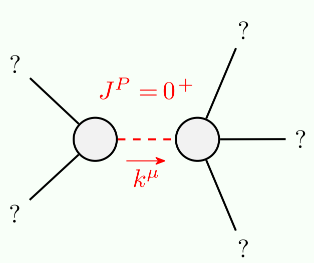
	$\sigma^{\#1}_{2^{+}}{}^{\dagger\alpha\beta}$	$\tau^{\#1}_{2^{+}}{}^{\dagger\alpha\beta}$	$\sigma^{\#1}_{2^{-}}{}^{\dagger\alpha\beta\chi}$
$\sigma^{\#1}_{2^{-}\alpha\beta\chi}$	0	0	$\frac{1}{-\frac{\alpha_0}{4}+\beta_1}$
$\tau^{\#1}_{2^{+}\alpha\beta}$	$\frac{2 i \sqrt{2}}{\alpha_0 k}$	$\frac{2}{\alpha_0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

Quadratic (free) action

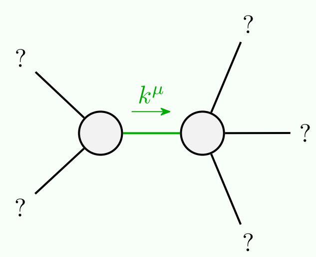
$\mathcal{S}_{\mathrm{F}} ==$

$$\iiiint\Big(-\tfrac{1}{2}(\alpha_0-4\beta_1)\,\omega^{\alpha\beta}{}_{\alpha}\,\omega_{\beta}{}^{\chi}{}_{\chi} - 2\beta_1\,\omega_{\alpha}{}^{\chi\delta}\,\omega_{\chi\delta}{}^{\alpha} + f^{\alpha\beta}\,\tau_{\alpha\beta} + \omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} - 2\beta_1\,\omega_{\alpha}{}^{\chi}{}_{\chi}\,\partial_{\beta}f^{\alpha\beta} - 2\beta_1\,\omega_{\alpha}{}^{\delta}{}_{\delta}\,\partial_{\beta}f^{\alpha\beta} - \alpha_0\,f^{\alpha\beta}\,\partial_{\beta}\omega_{\alpha}{}^{\chi}{}_{\chi} + \alpha_0\,\partial_{\beta}\omega^{\alpha\beta}{}_{\alpha} + 2\beta_1\,\omega_{\beta}{}^{\chi}{}_{\chi}\,\partial^{\beta}f^{\alpha}{}_{\alpha} + 2\beta_1\,\omega_{\beta}{}^{\delta}{}_{\delta}\,\partial^{\beta}f^{\alpha}{}_{\alpha} - 2\beta_1\,\partial_{\beta}f^{\chi}{}_{\chi}\,\partial^{\beta}f^{\alpha}{}_{\alpha} + \alpha_0\,f^{\alpha\beta}\,\partial_{\chi}\omega_{\alpha}{}^{\chi}{}_{\beta} - \alpha_0\,f^{\alpha}{}_{\alpha}\,\partial_{\chi}\omega^{\beta\chi}{}_{\beta} + \omega_{\alpha\chi\beta}\big(-\tfrac{1}{2}\alpha_0\,\omega^{\alpha\beta\chi} + 4\beta_1\,\partial^{\chi}f^{\alpha\beta}\big) + \beta_1\,\partial_{\chi}f_{\beta}{}^{\delta}\,\partial^{\chi}f_{\delta}{}^{\beta} + \beta_1\,\partial_{\chi}f^{\delta}{}_{\beta}\,\partial^{\chi}f_{\delta}{}^{\beta} + 4\beta_1\,\partial^{\beta}f^{\alpha}{}_{\alpha}\,\partial_{\delta}f_{\beta}{}^{\delta} - 2\beta_1\,\partial_{\beta}f_{\chi}{}^{\beta}\,\partial_{\delta}f^{\chi\delta} + \tfrac{2}{3}\alpha_6\,\partial_{\beta}\omega^{\alpha\beta}{}_{\alpha}\,\partial_{\delta}\omega^{\chi\delta}{}_{\chi} - \beta_1\,\partial^{\chi}f_{\zeta}{}^{\beta}\,\partial^{\zeta}f_{\beta\chi} - \beta_1\,\partial^{\chi}f_{\zeta}{}^{\beta}\,\partial^{\zeta}f_{\chi\beta} + \beta_1\,\partial^{\chi}f_{\delta\zeta}\,\partial^{\zeta}f^{\delta}{}_{\chi} - \beta_1\,\partial^{\chi}f_{\zeta\delta}\,\partial^{\zeta}f^{\delta}{}_{\chi}\Big)[t,x,y,z]\,dz\,dy\,dx\,dt$$

Massive and massless spectra



Massive particle	
Pole residue:	$\frac{1}{\alpha_0}+\frac{1}{\alpha_6}-\frac{1}{4\beta_1} > 0$
Polarisations:	1
Square mass:	$-\frac{\alpha_0(\alpha_0-4\beta_1)}{8\alpha_6\beta_1} > 0$
Spin:	0
Parity:	Even



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

Unitarity conditions

$\alpha_0 > 0$ && $\alpha_6 > 0$ && $\beta_1 < 0 \,||\, \beta_1 > \frac{\alpha_0}{4}$