

Particle spectrograph

Wave operator and propagator

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

	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^+}^{\#1}$
$\sigma_{0^+}^{\#1} \dagger$	$\frac{8\beta_1}{\alpha_0^2-4\alpha_0\beta_1+8\alpha_6\beta_1k^2}$	$-\frac{i\sqrt{2}(\alpha_0-4\beta_1)}{\alpha_0(\alpha_0-4\beta_1)k+8\alpha_6\beta_1k^3}$	0	0
$\tau_{0^+}^{\#1} \dagger$	$\frac{i\sqrt{2}(\alpha_0-4\beta_1)}{\alpha_0(\alpha_0-4\beta_1)k+8\alpha_6\beta_1k^3}$	$-\frac{\alpha_0-4\beta_1+2\alpha_6k^2}{k^2(\alpha_0^2-4\alpha_0\beta_1+8\alpha_6\beta_1k^2)}$	0	0
$\tau_{0^+}^{\#2} \dagger$	0	0	0	0
$\sigma_{0^+}^{\#1} \dagger$	0	0	0	$\frac{2}{\alpha_0-4\beta_1}$

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

Quadratic (free) action

$$S ==$$

$$\iiint\iiint (-\frac{1}{2}(\alpha_0-4\beta_1)\omega^{\alpha\beta}{}_\alpha\omega_\beta{}^\chi{}_\chi + f^{\alpha\beta}\tau_{\alpha\beta} + \omega^{\alpha\beta\chi}\sigma_{\alpha\beta\chi} - 4\beta_1\omega_\alpha{}^\chi{}_\chi\partial_\beta f^{\alpha\beta} - \alpha_0 f^{\alpha\beta}\partial_\beta\omega_\alpha{}^\chi{}_\chi + \alpha_0\partial_\beta\omega^{\alpha\beta}{}_\alpha + 4\beta_1\omega_\beta{}^\chi{}_\chi\partial^\beta f^\alpha{}_\alpha - 2\beta_1\partial_\beta f^\chi{}_\chi\partial^\beta f^\alpha{}_\alpha - 2\beta_1\partial_\beta f^{\alpha\beta}\partial_\chi f^\chi{}_\alpha + 4\beta_1\partial^\beta f^\alpha{}_\alpha\partial_\chi f^\chi{}_\beta + \alpha_0 f^{\alpha\beta}\partial_\chi\omega_\alpha{}^\chi{}_\beta - \alpha_0 f^\alpha{}_\alpha\partial_\chi\omega^{\beta\chi}{}_\beta - 2\beta_1\partial_\alpha f_{\beta\chi}\partial^\chi f^{\alpha\beta} - \beta_1\partial_\alpha f_{\chi\beta}\partial^\chi f^{\alpha\beta} + \beta_1\partial_\beta f_{\alpha\chi}\partial^\chi f^{\alpha\beta} + \beta_1\partial_\chi f_{\alpha\beta}\partial^\chi f^{\alpha\beta} + \beta_1\partial_\chi f_{\beta\alpha}\partial^\chi f^{\alpha\beta} - \frac{1}{2}\omega_{\alpha\chi\beta}((\alpha_0-4\beta_1)\omega^{\alpha\beta\chi} - 8\beta_1\partial^\chi f^{\alpha\beta}) + \frac{2}{3}\alpha_6\partial_\beta\omega^{\alpha\beta}{}_\alpha\partial_\delta\omega^{\chi\delta}{}_\chi)[t,x,y,z]dzdydxdtdt$$

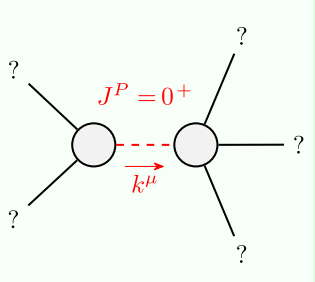
	$\omega_{2^+}^{\#1} \dagger^{\alpha\beta}$	$f_{2^+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{2^+}^{\#1} \dagger^{\alpha\beta\chi}$
$\omega_{2^+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{\alpha_0}{4} + \beta_1$	$\frac{i(\alpha_0-4\beta_1)k}{2\sqrt{2}}$	0
$f_{2^+}^{\#1} \dagger^{\alpha\beta}$	$\frac{i(\alpha_0-4\beta_1)k}{2\sqrt{2}}$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

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

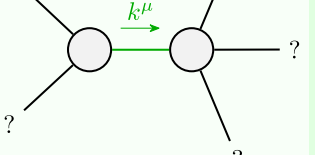
	$\sigma_{2^+}^{\#1} \dagger^{\alpha\beta}$	$\tau_{2^+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{2^+}^{\#1} \dagger^{\alpha\beta\chi}$
$\sigma_{2^+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{16\beta_1}{\alpha_0^2-4\alpha_0\beta_1}$	$\frac{2i\sqrt{2}}{\alpha_0k}$	0
$\tau_{2^+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{2i\sqrt{2}}{\alpha_0k}$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

	$\omega_0^{\#1} \dagger$	$f_0^{\#2} \dagger$	$\omega_0^{\#1} \dagger$
$\omega_0^{\#1} \dagger$	$\frac{\alpha_0}{2} - 2\beta_1 + \alpha_6k^2$	$-\frac{i(\alpha_0-4\beta_1)k}{\sqrt{2}}$	0
$f_0^{\#1} \dagger$	$\frac{i(\alpha_0-4\beta_1)k}{\sqrt{2}}$	$-4\beta_1k^2$	0
$f_0^{\#2} \dagger$	0	0	0
$\omega_0^{\#1} \dagger$	0	0	$\frac{1}{2}(\alpha_0-4\beta_1)$

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

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