

Particle spectrograph

Wave operator and propagator

	$\omega_{2^{+}\alpha\beta}^{\#1}$	$f_{2^{+}\alpha\beta}^{\#1}$	$\omega_{2^{-}\alpha\beta\chi}^{\#1}$
$\omega_{2^{+}}^{\#1}\dagger^{\alpha\beta}$	$\frac{t_1}{2}$	$-\frac{ik t_1}{\sqrt{2}}$	0
$f_{2^{+}}^{\#1}\dagger^{\alpha\beta}$	$\frac{ik t_1}{\sqrt{2}}$	$k^2 t_1$	0
$\omega_{2^{-}}^{\#1}\dagger^{\alpha\beta\chi}$	0	0	$k^2 r_1 + \frac{t_1}{2}$

Source constraints		
SO(3) irreps	Fundamental fields	Multiplicities
$\tau_{0^{+}}^{\#2} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == 0$	1
$\tau_{0^{+}}^{\#1} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha_\alpha$	1
$\tau_1^{\#2\alpha} + 2\,i\,k\,\sigma_1^{\#2\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^X \partial_\beta \tau^{\alpha\beta} + 2\,\partial_\delta \partial^\delta \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi}$	3
$\tau_1^{\#1\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^X \partial_\beta \tau^{\beta\alpha}$	3
$\tau_{1^{+}}^{\#1\alpha\beta} + i\,k\,\sigma_1^{\#2\alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^X \tau^{\alpha\beta} +$ $2\,\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 2\,\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} ==$ $\partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} +$ $\partial_\chi \partial^X \tau^{\beta\alpha} + 2\,\partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta}$	3
$\tau_{2^{+}}^{\#1\alpha\beta} - 2\,i\,k\,\sigma_{2^{+}}^{\#1\alpha\beta} == 0$	$-i\,(4\,\partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2\,\partial_\delta \partial^\delta \partial^\beta \partial^\alpha \tau^\chi_\chi -$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} - 3\,\partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta} -$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\alpha\chi} - 3\,\partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} +$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial^X \tau^{\alpha\beta} + 3\,\partial_\delta \partial^\delta \partial_\chi \partial^X \tau^{\beta\alpha} +$ $4\,i\,k^X\,\partial_\epsilon \partial_\chi \partial^\beta \partial^\alpha \sigma^{\delta\epsilon}_\delta -$ $6\,i\,k^X\,\partial_\epsilon \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\delta\epsilon} -$ $6\,i\,k^X\,\partial_\epsilon \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\delta\epsilon} +$ $2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} +$ $6\,i\,k^X\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\alpha\delta\beta} +$ $6\,i\,k^X\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\beta\delta\alpha} -$ $2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \tau^\chi_\chi -$ $4\,i\,\eta^{\alpha\beta}\,k^X\,\partial_\phi \partial^\phi \partial_\epsilon \partial_\chi \sigma^{\delta\epsilon}_\delta) == 0$	5
Total constraints/gauge generators:		16

	$\tau_{1^{-}\alpha}^{\#2}$	$\tau_{1^{-}\alpha}^{\#1}$	$\sigma_{1^{-}\alpha}^{\#2}$	$\sigma_{1^{-}\alpha}^{\#1}$	$\tau_{1^{+}\alpha\beta}^{\#1}$	$\sigma_{1^{+}\alpha\beta}^{\#2}$	$\sigma_{1^{+}\alpha\beta}^{\#1}$
$\sigma_{1^{+}}^{\#1}\dagger^{\alpha\beta}$	0	0	0	0	$-\frac{i\sqrt{2}\,k}{t_1+k^2t_1}$	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	0
$\sigma_{1^{+}}^{\#2}\dagger^{\alpha\beta}$	0	0	0	0	$\frac{-2ik^3(2r_3+r_5)+kt_1}{(1+k^2)^2t_1^2}$	$\frac{-2k^2(2r_3+r_5)+t_1}{(1+k^2)^2t_1^2}$	$-\frac{\sqrt{2}}{t_1+k^2t_1}$
$\tau_{1^{+}}^{\#1}\dagger^{\alpha\beta}$	0	0	0	0	$\frac{-2k^4(2r_3+r_5)+k^2t_1}{(1+k^2)^2t_1^2}$	$\frac{i(2k^3(2r_3+r_5)+kt_1)}{(1+k^2)^2t_1^2}$	$\frac{i\sqrt{2}\,k}{t_1+k^2t_1}$
$\sigma_{1^{+}}^{\#1}\dagger^\alpha$	$\frac{i}{k(1+2k^2)(r_1-2r_3-r_5)}$	0	$\frac{1}{\sqrt{2}(k^2+2k^4)(r_1-2r_3-r_5)}$	$\frac{1}{k^2(-r_1+2r_3+r_5)}$	0	0	0
$\sigma_{1^{+}}^{\#2}\dagger^\alpha$	$\frac{i(6k^2(r_1-2r_3-r_5)+t_1)}{\sqrt{2}\,k(1+2k^2)^2(r_1-2r_3-r_5)t_1}$	0	$\frac{1}{-r_1+2r_3+r_5}+\frac{6k^2}{2(k+2k^3)^2}$	$\frac{1}{\sqrt{2}(k^2+2k^4)(r_1-2r_3-r_5)}$	0	0	0
$\tau_{1^{+}}^{\#1}\dagger^\alpha$	0	0	0	0	0	0	0
$\tau_{1^{+}}^{\#2}\dagger^\alpha$	$\frac{1}{-r_1+2r_3+r_5}+\frac{6k^2}{(1+2k^2)^2}$	0	$-\frac{i(6k^2(r_1-2r_3-r_5)+t_1)}{\sqrt{2}\,k(1+2k^2)^2(r_1-2r_3-r_5)t_1}$	$\frac{i}{k(1+2k^2)(-r_1+2r_3+r_5)}$	0	0	0

	$\omega_{1^{+}\alpha\beta}^{\#1}$	$\omega_{1^{+}\alpha\beta}^{\#2}$	$f_{1^{+}\alpha\beta}^{\#1}$	$\omega_{1^{-}\alpha}^{\#1}$	$\omega_{1^{-}\alpha}^{\#2}$	$f_{1^{-}\alpha}^{\#1}$	$f_{1^{-}\alpha}^{\#2}$
$\omega_{1^{+}}^{\#1}\dagger^{\alpha\beta}$	$k^2(2r_3+r_5)-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ik t_1}{\sqrt{2}}$	0	0	0	0
$\omega_{1^{+}}^{\#2}\dagger^{\alpha\beta}$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$f_{1^{+}}^{\#1}\dagger^{\alpha\beta}$	$\frac{ik t_1}{\sqrt{2}}$	0	0	0	0	0	0
$\omega_{1^{-}}^{\#1}\dagger^\alpha$	0	0	0	$k^2(-r_1+2r_3+r_5)+\frac{t_1}{6}$	$\frac{t_1}{3\sqrt{2}}$	0	$\frac{ik t_1}{3}$
$\omega_{1^{-}}^{\#2}\dagger^\alpha$	0	0	0	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	0	$\frac{1}{3}i\sqrt{2}\,k t_1$
$f_{1^{-}}^{\#1}\dagger^\alpha$	0	0	0	0	0	0	0
$f_{1^{-}}^{\#2}\dagger^\alpha$	0	0	0	$-\frac{1}{3}i\,k t_1$	$-\frac{1}{3}i\sqrt{2}\,k t_1$	0	$\frac{2k^2t_1}{3}$

Quadratic (free) action

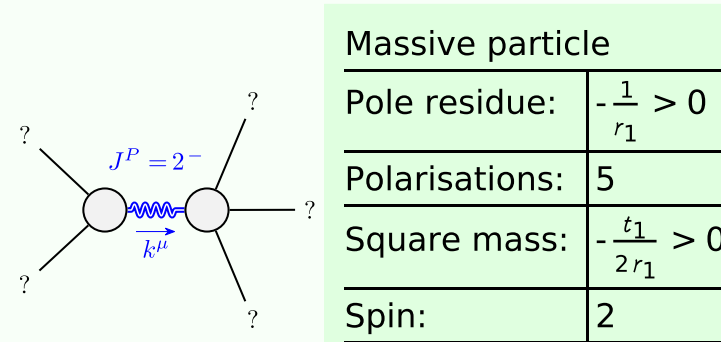
$$S = \int \int \int \int (\underbrace{f^{\alpha\beta}}_{\frac{1}{6}t_1(2\omega_{\alpha}^{\alpha i}\omega_{\beta}^{\theta}{}_{,\theta}-4\omega_{\alpha}^{\theta}{}_{,\theta}\partial_{\beta}f^{\alpha i}+4\omega_{\beta}^{\theta}{}_{,\theta}\partial_{\beta}f^{\alpha}{}_{,\alpha}-2\partial_{\beta}f^{\theta}{}_{\theta}} + \underbrace{\omega^{\alpha\beta\chi}}_{\partial_{\beta}f^{\alpha}{}_{,\alpha}-2\partial_{\beta}f^{\alpha i}\partial_{\theta}f^{\theta}{}_{,\theta}+4\partial_{\beta}f^{\alpha}{}_{,\alpha}\partial_{\theta}f^{\theta}{}_{,\theta}-6\partial_{\theta}f^{\beta}{}_{,\theta}\partial^{\theta}f^{\alpha i}} - \underbrace{\sigma^{\alpha\beta\chi}}_{3\partial_{\theta}f^{\theta}{}_{,\theta}\partial^{\theta}f^{\alpha i}+3\partial_{\beta}f^{\alpha\theta}\partial^{\theta}f^{\alpha i}+3\partial_{\theta}f^{\alpha i}\partial_{\alpha}\partial^{\theta}f^{\alpha i}} + \underbrace{\tau^{\alpha\beta\chi}}_{3\partial_{\theta}f^{\theta}{}_{,\theta}\partial^{\theta}f^{\alpha i}+6\omega_{\alpha\theta i}(\omega^{\alpha i\theta}+2\partial^{\theta}f^{\alpha i})) - \underbrace{\omega^{\alpha\beta}}_{2r_3(\partial_{\beta}\omega_{\alpha}^{\theta}{}_{,\theta}\partial^{\theta}\omega_{\beta}^{\alpha\beta}+\partial_{\beta}\omega_{\beta}^{\theta}{}_{,\theta}\partial^{\theta}\omega_{\theta}^{\alpha\beta}+\partial_{\alpha}\omega^{\alpha\beta i}\partial_{\theta}\omega_{\beta}^{\theta}{}_{,\theta}} + \underbrace{\omega^{\alpha\beta\chi}}_{2\partial^{\theta}\omega_{\alpha}^{\alpha\beta}\partial_{\theta}\omega_{\beta}^{\theta}{}_{,\theta}+\partial_{\alpha}\omega^{\alpha\beta i}\partial_{\theta}\omega_{\beta}^{\theta}{}_{,\theta}} - \underbrace{\omega^{\alpha\beta\chi}}_{2\partial^{\theta}\omega_{\alpha}^{\alpha\beta}\partial_{\theta}\omega_{\beta}^{\theta}{}_{,\theta}+2\partial_{\beta}\omega_{\alpha\theta i}\partial^{\theta}\omega^{\alpha\beta i}} + \underbrace{\omega^{\alpha\beta\chi}}_{\frac{2}{3}r_1(3\partial_{\beta}\omega_{\alpha}^{\theta}{}_{,\theta}\partial^{\theta}\omega_{\beta}^{\alpha\beta}+3\partial_{\beta}\omega_{\beta}^{\theta}{}_{,\theta}\partial^{\theta}\omega_{\theta}^{\alpha\beta}+3\partial_{\alpha}\omega^{\alpha\beta i}\partial_{\theta}\omega_{\beta}^{\theta}{}_{,\theta}} - \underbrace{\omega^{\alpha\beta\chi}}_{6\partial^{\theta}\omega_{\alpha}^{\alpha\beta}\partial_{\theta}\omega_{\beta}^{\theta}{}_{,\theta}+3\partial_{\alpha}\omega^{\alpha\beta i}\partial_{\theta}\omega_{\beta}^{\theta}{}_{,\theta}-6\partial^{\theta}\omega_{\alpha}^{\alpha\beta}\partial_{\theta}\omega_{\beta}^{\theta}{}_{,\theta}} - \underbrace{\omega^{\alpha\beta\chi}}_{2\partial_{\beta}\omega_{\alpha i\theta}\partial^{\theta}\omega^{\alpha\beta i}+\partial_{\beta}\omega_{\alpha\theta i}\partial^{\theta}\omega^{\alpha\beta i}+2\partial_{\beta}\omega_{i\theta\alpha}\partial^{\theta}\omega^{\alpha\beta i}} + \underbrace{\omega^{\alpha\beta\chi}}_{\partial_{\beta}\omega_{\alpha\theta\beta}\partial^{\theta}\omega^{\alpha\beta i}+\partial_{\theta}\omega_{\alpha\beta i}\partial^{\theta}\omega^{\alpha\beta i}+\partial_{\theta}\omega_{\alpha\beta}\partial^{\theta}\omega^{\alpha\beta i}} + \underbrace{\omega^{\alpha\beta\chi}}_{r_5(\partial_{\beta}\omega_{\theta}^{\alpha}{}_{,\kappa}\partial^{\theta}\omega^{\alpha i}{}_{,\kappa}-\partial_{\theta}\omega_{\alpha}^{\kappa}{}_{,\kappa}\partial^{\theta}\omega^{\alpha i}{}_{,\alpha}-(\partial_{\alpha}\omega^{\alpha i\theta}-2\partial^{\theta}\omega^{\alpha i}{}_{,\alpha})(\partial_{\chi}\omega_{\beta}^{\kappa}-\partial_{\chi}\omega_{\theta}^{\kappa}))})[t,x,y,z]dzdydxdt$$

	$\sigma_{0^{+}}^{\#1}$	$\tau_{0^{+}}^{\#1}$	$\tau_{0^{+}}^{\#2}$	$\sigma_{0^{+}}^{\#1}$
$\sigma_{0^{+}}^{\#1}\dagger$	$\frac{1}{6k^2(-r_1+r_3)}$	0	0	0
$\tau_{0^{+}}^{\#1}\dagger$	0	0	0	0
$\tau_{0^{+}}^{\#2}\dagger$	0	0	0	0
$\sigma_{0^{+}}^{\#1}\dagger$	0	0	0	$-\frac{1}{t_1}$

	$\sigma_{2^{+}\alpha\beta}^{\#1}$	$\tau_{2^{+}\alpha\beta}^{\#1}$	$\sigma_{2^{-}\alpha\beta\chi}^{\#1}$
$\sigma_{2^{+}}^{\#1}\dagger^{\alpha\beta}$	$\frac{2}{(1+2k^2)^2t_1}$	$-\frac{2i\sqrt{2}\,k}{(1+2k^2)^2t_1}$	0
$\tau_{2^{+}}^{\#1}\dagger^{\alpha\beta}$	$\frac{2i\sqrt{2}\,k}{(1+2k^2)^2t_1}$	$\frac{4k^2}{(1+2k^2)^2t_1}$	0
$\sigma_{2^{+}}^{\#1}\dagger^{\alpha\beta\chi}$	0	0	$\frac{2}{2k^2r_1+t_1}$

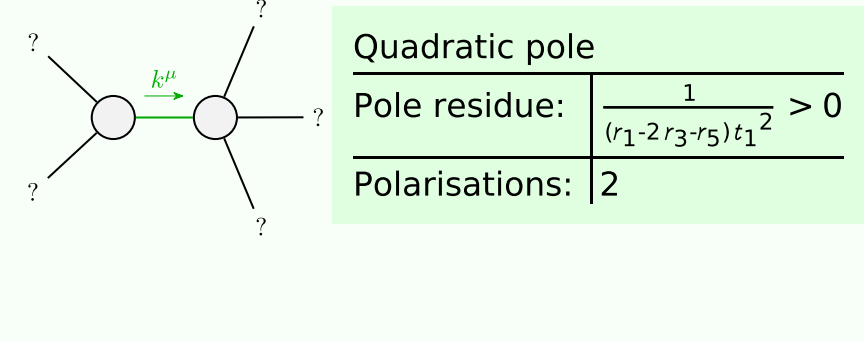
	$f_{0^{+}}^{\#1}$	$f_{0^{+}}^{\#2}$	$\omega_{0^{-}}^{\#1}$
$\omega_{0^{+}}^{\#1}\dagger$	0	0	0
$f_{0^{+}}^{\#1}\dagger$	0	0	0
$f_{0^{+}}^{\#2}\dagger$	0	0	0
$\omega_{0^{-}}^{\#1}\dagger$	$6k^2(-r_1+r_3)$	0	$-t_1$

Massive and massless spectra



Massive particle

Pole residue:	$-\frac{1}{r_1} > 0$
Polarisations:	5
Square mass:	$-\frac{t_1}{2r_1} > 0$
Spin:	2
Parity:	Odd



Quadratic pole

Pole residue:	$\frac{1}{(r_1-2r_3-r_5)t_1^2} > 0$
Polarisations:	2

Unitarity conditions

$r_1 < 0 \ \&\& \ r_5 < r_1 - 2\,r_3 \ \&\& \ t_1 > 0$