

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

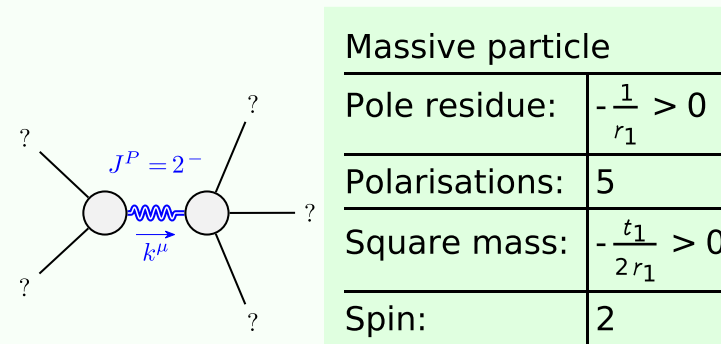
$$S = \int \int \int \int (\omega^{\alpha\beta} \tau_{\alpha\beta} + \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + \frac{1}{6} t_1 (2 \omega^{\alpha\iota} \omega^{\theta}_{\iota\theta} - 4 \omega^{\theta}_{\alpha\theta} \partial_{\iota} f^{\alpha\iota} + 4 \omega^{\theta}_{\iota\theta} \partial_{\iota} f^{\alpha}_{\alpha} - 2 \partial_{\iota} f^{\theta}_{\alpha} \partial^{\iota} f^{\alpha}_{\alpha} - 2 \partial_{\iota} f^{\alpha\iota} \partial_{\theta} f^{\theta}_{\alpha} + 4 \partial_{\iota} f^{\alpha}_{\alpha} \partial_{\theta} f^{\theta}_{\iota} - 6 \partial_{\theta} f^{\iota}_{\iota\theta} \partial^{\theta} f^{\alpha\iota}_{\alpha} - 3 \partial_{\theta} f^{\theta}_{\alpha\iota} \partial^{\theta} f^{\alpha\iota}_{\alpha} + 3 \partial_{\theta} f^{\alpha\iota}_{\alpha\theta} \partial^{\theta} f^{\alpha\iota}_{\alpha} + 3 \partial_{\theta} f^{\alpha\iota}_{\alpha} (\omega^{\alpha\iota\theta} + 2 \partial^{\theta} f^{\alpha\iota}_{\alpha})) - 2 r_3 (\partial_{\beta} \omega^{\theta}_{\iota\theta} \partial^{\iota} \omega^{\alpha\beta}_{\alpha} + \partial_{\iota} \omega^{\theta}_{\beta\theta} \partial^{\iota} \omega^{\alpha\beta}_{\alpha} + \partial_{\alpha} \omega^{\alpha\beta\iota}_{\alpha} \partial_{\theta} \omega^{\theta}_{\beta\iota} - 2 \partial^{\iota} \omega^{\alpha\beta}_{\alpha} \partial_{\theta} \omega^{\theta}_{\beta\iota} + \partial_{\alpha} \omega^{\alpha\beta\iota}_{\alpha} \partial_{\theta} \omega^{\theta}_{\beta\iota} - 2 \partial^{\iota} \omega^{\alpha\beta}_{\alpha} \partial_{\theta} \omega^{\theta}_{\beta\iota} + 2 \partial_{\beta} \omega^{\alpha\beta}_{\alpha} \partial_{\theta} \omega^{\theta}_{\iota\theta} + 2 \partial_{\beta} \omega^{\alpha\beta\iota}_{\alpha} \partial^{\theta} \omega^{\alpha\beta\iota}_{\alpha} + \partial_{\theta} \omega^{\alpha\beta\iota}_{\alpha\beta} \partial^{\theta} \omega^{\alpha\beta\iota}_{\alpha} + \partial_{\theta} \omega^{\alpha\beta\iota}_{\alpha\beta} \partial^{\theta} \omega^{\alpha\beta\iota}_{\alpha}) + r_5 (\partial_{\iota} \omega^{\kappa}_{\theta\kappa} \partial^{\theta} \omega^{\alpha\iota}_{\alpha} - \partial_{\theta} \omega^{\kappa}_{\alpha\kappa} \partial^{\theta} \omega^{\alpha\iota}_{\alpha} - (\partial_{\alpha} \omega^{\alpha\iota\theta}_{\alpha} - (\partial_{\alpha} \omega^{\alpha\iota\theta}_{\alpha} - 2 \partial^{\theta} \omega^{\alpha\iota}_{\alpha}) (\partial_{\chi} \omega^{\kappa}_{\iota\theta} - \partial_{\chi} \omega^{\kappa}_{\theta\iota}))) [t, x, y, z] dz dy dx dt$$

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

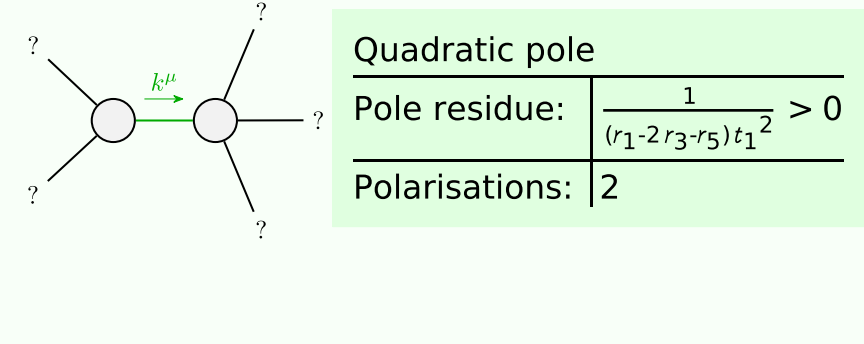
	$f_{0^{+}}^{\#1}$	$f_{0^{+}}^{\#2}$	$\omega_{0^{-}}^{\#1}$
$\omega_{0^{+}}^{\#1}\dagger$	0	0	0
$f_{0^{+}}^{\#1}\dagger$	0	0	0
$f_{0^{+}}^{\#2}\dagger$	0	0	0
$\omega_{0^{-}}^{\#1}\dagger$	0	0	$-t_1$

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

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