

Particle spectrograph

Wave operator and propagator

Source constraints			
SO(3) irreps	Fundamental fields	Multiplicities	
$\tau^{#2}_{0+} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == 0$	1	
$\tau^{#1}_{0+} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha_\alpha$	1	
$\sigma^{#1}_{0+} == 0$	$\partial_\beta \sigma^{\alpha\beta}_\alpha == 0$	1	
$\tau^{#2\alpha}_1 + 2\,i\,k\,\sigma^{#1\alpha}_1 == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} +$ $2\,(\partial_\delta \partial^\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi}_\beta - \partial_\delta \partial^\delta \partial_\chi \partial_\sigma \sigma^{\alpha\beta\chi} +$ $\partial_\delta \partial^\delta \partial_\chi \partial^\chi \sigma^{\alpha\beta}_\beta) == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta}$	3	
$\tau^{#1\alpha}_1 == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\beta\alpha}$	3	
$\sigma^{#1\alpha}_1 == \sigma^{#2\alpha}_1$	$\partial_\chi \partial^\alpha \sigma^{\beta\chi}_\beta + \partial_\chi \partial^\chi \sigma^{\alpha\beta}_\beta == 0$	3	
$\tau^{#1\alpha\beta}_1 + i\,k\,\sigma^{#2\alpha\beta}_1 == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} +$ $2\,\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 2\,\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} ==$ $\partial_\chi \partial^{\alpha-\chi\beta} + \partial_\chi \partial^{\beta-\alpha\chi} +$ $\partial_\chi \partial^\chi \tau^{\beta\alpha} + 2\,\partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta}$	3	
$\tau^{#1\alpha\beta}_2 - 2\,i\,k\,\sigma^{#1\alpha\beta}_2 == 0$	$-i\,(4\,\partial_\delta \partial_\chi \partial_\beta \partial^\alpha \tau^{\chi\delta} + 2\,\partial_\delta \partial^\delta \partial_\beta \partial^\alpha \tau^\chi_\chi -$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} - 3\,\partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta} -$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial_\beta \tau^{\alpha\chi} - 3\,\partial_\delta \partial^\delta \partial_\chi \partial_\beta \tau^{\chi\alpha} +$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\alpha\beta} + 3\,\partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\beta\alpha} +$ $4\,i\,k^\chi\,\partial_\epsilon \partial_\chi \partial_\beta \partial^\alpha \sigma^{\delta\epsilon}_\delta -$ $6\,i\,k^\chi\,\partial_\epsilon \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\delta\epsilon}_\epsilon -$ $6\,i\,k^\chi\,\partial_\epsilon \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\delta\epsilon}_\epsilon +$ $2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} +$ $6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\alpha\delta\beta}_\beta +$ $6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\beta\delta\alpha}_\alpha -$ $2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \tau^\chi_\chi -$ $4\,i\,\eta^{\alpha\beta}\,k^\chi\,\partial_\phi \partial_\delta \partial_\epsilon \partial_\chi \sigma^{\delta\epsilon}_\delta) == 0$	5	
Total constraints/gauge generators:		20	

Quadratic (free) action

$$S = \iiint \Big( \frac{1}{6} \, (2\,t_1\,\omega^\alpha_\alpha\,\omega^\theta_{\phantom{\theta}\theta} + 6\,f^{\alpha\beta}\,\tau_{\alpha\beta} + 6\,\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} - 4\,t_1\,\omega^\theta_\alpha\,\partial_\theta f^{\alpha\iota} +$$
  
$$4\,t_1\,\omega^\theta_{\phantom{\theta}\theta}\,\partial_\theta f^\alpha_\alpha - 2\,t_1\,\partial_\theta f^\theta_\theta\,\partial_\theta f^\alpha_\alpha - 2\,t_1\,\partial_\theta f^{\alpha\iota}\,\partial_\theta f^\theta_\alpha +$$
  
$$4\,t_1\,\partial_\theta f^\alpha_\alpha\,\partial_\theta f^\theta_{\phantom{\theta}\theta} - 6\,t_1\,\partial_\theta f_{\phantom{\theta}\theta}\,\partial^\theta f^{\alpha\iota} - 3\,t_1\,\partial_\theta f_{\theta\iota}\,\partial^\theta f^{\alpha\iota} +$$
  
$$3\,t_1\,\partial_\theta f_{\alpha\theta}\,\partial^\theta f^{\alpha\iota} + 3\,t_1\,\partial_\theta f_{\alpha\iota}\,\partial^\theta f^{\alpha\iota} + 3\,t_1\,\partial_\theta f_{\iota\alpha}\,\partial^\theta f^{\alpha\iota} +$$
  
$$6\,t_1\,\omega_{\alpha\theta\iota}\,(\omega^{\alpha\iota\theta} + 2\,\partial^\theta f^{\alpha\iota}) + 8\,r_2\,\partial_\beta \omega_{\alpha\iota\theta}\,\partial^\theta \omega^{\alpha\beta\iota} -$$
  
$$4\,r_2\,\partial_\beta \omega_{\alpha\theta\iota}\,\partial^\theta \omega^{\alpha\beta\iota} + 4\,r_2\,\partial_\beta \omega_{\iota\theta\alpha}\,\partial^\theta \omega^{\alpha\beta\iota} -$$
  
$$2\,r_2\,\partial_\iota \omega_{\alpha\beta\theta}\,\partial^\theta \omega^{\alpha\beta\iota} + 2\,r_2\,\partial_\theta \omega_{\alpha\beta\iota}\,\partial^\theta \omega^{\alpha\beta\iota} -$$
  
$$4\,r_2\,\partial_\theta \omega_{\alpha\iota\beta}\,\partial^\theta \omega^{\alpha\beta\iota}) [t,\,x,\,y,\,z] dz\,dy\,dx\,dt$$

	$\sigma^{#1}_{1+}\alpha\beta$	$\sigma^{#2}_{1+}\alpha\beta$	$\tau^{#1}_{1+}\alpha\beta$	$\sigma^{#1}_{1-}\alpha$	$\sigma^{#2}_{1-}\alpha$	$\tau^{#1}_{1-}\alpha$	$\tau^{#2}_{1-}\alpha$
$\sigma^{#1}_{1+}\alpha\beta$	0	$-\frac{\sqrt{2}}{t_1+k^2}t_1$	$-\frac{i\sqrt{2}k}{t_1+k^2}t_1$	0	0	0	0
$\sigma^{#2}_{1+}\alpha\beta$	$-\frac{\sqrt{2}}{t_1+k^2}t_1$	$\frac{1}{(1+k^2)^2}t_1$	$\frac{ik}{(1+k^2)^2}t_1$	0	0	0	0
$\tau^{#1}_{1+}\alpha\beta$	$\frac{i\sqrt{2}k}{t_1+k^2}t_1$	$-\frac{ik}{(1+k^2)^2}t_1$	$\frac{k^2}{(1+k^2)^2}t_1$	0	0	0	0
$\sigma^{#1}_{1-}\alpha$	0	0	0	$\frac{6}{(3+4k^2)^2}t_1$	$\frac{6\sqrt{2}}{(3+4k^2)^2}t_1$	0	$\frac{12ik}{(3+4k^2)^2}t_1$
$\sigma^{#2}_{1-}\alpha$	0	0	0	$\frac{6\sqrt{2}}{(3+4k^2)^2}t_1$	$\frac{12}{(3+4k^2)^2}t_1$	0	$\frac{12i\sqrt{2}k}{(3+4k^2)^2}t_1$
$\tau^{#1}_{1-}\alpha$	0	0	0	0	0	0	0
$\tau^{#2}_{1-}\alpha$	0	0	0	$-\frac{12ik}{(3+4k^2)^2}t_1$	$-\frac{12i\sqrt{2}k}{(3+4k^2)^2}t_1$	0	$\frac{24k^2}{(3+4k^2)^2}t_1$

	$\omega^{#1}_{1+}\alpha\beta$	$\omega^{#2}_{1+}\alpha\beta$	$f^{#1}_{1+}\alpha\beta$	$\omega^{#1}_{1-}\alpha$	$\omega^{#2}_{1-}\alpha$	$f^{#1}_{1-}\alpha$	$f^{#2}_{1-}\alpha$
$\omega^{#1}_{1+}\alpha\beta$	$-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$\omega^{#2}_{1+}\alpha\beta$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$f^{#1}_{1+}\alpha\beta$	$\frac{ikt_1}{\sqrt{2}}$	0	0	0	0	0	0
$\omega^{#1}_{1-}\alpha$	0	0	0	$\frac{t_1}{6}$	$\frac{t_1}{3\sqrt{2}}$	0	$\frac{ikt_1}{3}$
$\omega^{#2}_{1-}\alpha$	0	0	0	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	0	$\frac{\frac{1}{3}i\sqrt{2}kt_1}{3}$
$f^{#1}_{1-}\alpha$	0	0	0	0	0	0	0
$f^{#2}_{1-}\alpha$	0	0	0	$-\frac{\frac{1}{3}ikt_1}{3}$	$-\frac{\frac{1}{3}i\sqrt{2}kt_1}{3}$	0	$\frac{2k^2t_1}{3}$

$\omega_0^{*1}$	$\emptyset$	$\emptyset$	$\emptyset$	$k^2r_2-t_1$
$\omega_0^{*2}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
$f_0^{*1}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
$f_0^{*2}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
$\omega_0^{*3}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
$\omega_0^{*4}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
$\omega_0^{*5}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
$\sigma_0^{*1}$	$\emptyset$	$\emptyset$	$\emptyset$	$\frac{1}{k^2r_2-t_1}$
$\sigma_0^{*2}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
$\tau_0^{*1}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
$\tau_0^{*2}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
$\sigma_0^{*3}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
$\sigma_0^{*4}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
$\sigma_0^{*5}$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$

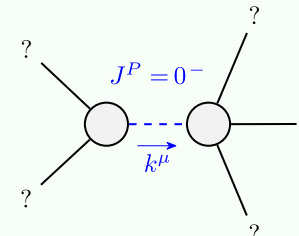
$\omega_{2+}^{*1}\alpha\beta$  $f_{2+}^{*1}\alpha\beta$  $\omega_{2-}^{*1}\alpha\beta\chi$

$\omega_{2+}^{*1}\alpha\beta$	$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	$\emptyset$
$f_{2+}^{*1}\alpha\beta$	$\frac{ikt_1}{\sqrt{2}}$	$k^2t_1$	$\emptyset$
$\omega_{2-}^{*1}\alpha\beta\chi$	$\emptyset$	$\emptyset$	$\frac{t_1}{2}$

$\sigma_{2+}^{*1}\alpha\beta$  $\tau_{2+}^{*1}\alpha\beta$  $\sigma_{2-}^{*1}\alpha\beta\chi$

$\sigma_{2+}^{*1}\alpha\beta$	$\frac{2}{(1+2k^2)^2t_1}$	$-\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$	$\emptyset$
$\tau_{2+}^{*1}\alpha\beta$	$\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$	$\frac{4k^2}{(1+2k^2)^2t_1}$	$\emptyset$
$\sigma_{2-}^{*1}\alpha\beta\chi$	$\emptyset$	$\emptyset$	$\frac{2}{t_1}$

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{r_2} > 0$
Polarisations:	1
Square mass:	$\frac{t_1}{r_2} > 0$
Spin:	0
Parity:	Odd

(no massless particles)

Unitarity conditions

$r_2 < 0 \ \&\& \ t_1 < 0$