

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
$\sigma^{#1}_0{}^+ == 0$	$\partial_\beta \sigma^{\alpha\beta}{}_\alpha = 0$	1
$\tau^{#2\alpha}{}_{1-} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta}$	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
$\sigma^{#2\alpha}{}_{1-} == 0$	$\partial_\chi \partial_\beta \sigma^{\alpha\beta\chi} = 0$	3
$\sigma^{#1\alpha}{}_{1-} == 0$	$\partial_\chi \partial^\alpha \sigma^{\beta\chi}{}_\beta + \partial_\chi \partial^\chi \sigma^\alpha{}_\beta{}^\beta == \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi}$	3
$\tau^{#1\alpha\beta}{}_{1+} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} == \partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\chi \tau^{\beta\alpha}$	3
$\sigma^{#2\alpha\beta}{}_{1+} == 0$	$\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} == \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta}$	3
$\sigma^{#1\alpha\beta}{}_{1+} == 0$	$\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} == \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha}$	3
$\sigma^{#1\alpha\beta}{}_{2+} == 0$	$2\partial_\delta \partial^\beta \partial^\alpha \sigma^{\chi\delta}{}_\chi + 3(\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha}) == 3\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 3\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 3\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 2\eta^{\alpha\beta}\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\chi\delta}{}_\chi$	5
$\sigma^{#1\alpha\beta\chi}{}_{2-} == 0$	$3\partial_\epsilon \partial_\delta \partial^\chi \partial^\alpha \sigma^{\beta\delta\epsilon} + 3\partial_\epsilon \partial^\epsilon \partial^\chi \partial^\alpha \sigma^{\beta\delta}{}_\delta + 2\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\chi\delta} + 4\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\delta\chi} + 2\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\chi\delta\alpha} + 4\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\delta\chi} + 2\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\chi\delta} + 2\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\beta\delta\alpha} + 4\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\beta\chi} + 2\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\chi\beta} + 3\eta^{\alpha\chi}\partial_\phi \partial^\phi \partial_\epsilon \sigma^{\delta\epsilon}{}_\delta + 3\eta^{\beta\chi}\partial_\phi \partial^\phi \partial_\epsilon \sigma^{\alpha\delta}{}_\delta == 3\partial_\epsilon \partial_\delta \partial^\chi \partial^\beta \sigma^{\alpha\delta\epsilon} + 3\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\delta}{}_\delta + 2\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\beta\chi\delta} + 4\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\beta\delta\chi} + 2\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\chi\delta\beta} + 2\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\beta\delta\alpha} + 4\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\beta\chi} + 2\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\chi\beta} + 3\eta^{\alpha\chi}\partial_\phi \partial^\phi \partial_\epsilon \sigma^{\delta\epsilon}{}_\delta + 3\eta^{\beta\chi}\partial_\phi \partial^\phi \partial_\epsilon \sigma^{\alpha\delta}{}_\delta + 3\eta^{\alpha\chi}\partial_\phi \partial^\phi \partial_\epsilon \sigma^{\beta\delta}{}_\delta$	5
Total constraints/gauge generators:		33

Quadratic (free) action

$$S == \iiint \big(f^{\alpha\beta} \tau_{\alpha\beta} + \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + \beta_1 (-4 \omega^{\chi}{}_{\chi} \partial_\rho f^{\alpha\beta} + 4 \partial_\beta \omega^{\alpha\beta}{}_{\alpha} + 4 \omega^{\chi}{}_{\beta} \partial^\beta f^{\alpha}{}_{\alpha} - 2 \partial_\beta f^{\chi}{}_{\chi} \partial^\beta f^{\alpha}{}_{\alpha} - 2 \partial_\beta f^{\alpha\beta} \partial_\chi f^{\chi}{}_{\alpha} + 4 \partial^\beta f^{\alpha}{}_{\alpha} \partial_\chi f^{\chi}{}_{\beta} - 4 f^{\alpha\beta} (\partial_\beta \omega^{\chi}{}_{\chi} - \partial_\chi \omega^{\chi}{}_{\beta}) - 4 f^{\alpha}{}_{\alpha} \partial_\chi \omega^{\beta\chi}{}_{\beta} + 4 \omega_{\alpha\chi\beta} \partial^\chi f^{\alpha\beta} - 2 \partial_\alpha f_{\beta\chi} \partial^\chi f^{\alpha\beta} - \partial_\alpha f_{\chi\beta} \partial^\chi f^{\alpha\beta} + \partial_\beta f_{\alpha\chi} \partial^\chi f^{\alpha\beta} + \partial_\chi f_{\alpha\beta} \partial^\chi f^{\alpha\beta} + \partial_\chi f_{\beta\alpha} \partial^\chi f^{\alpha\beta} \big) + \frac{1}{3} \alpha_3 (4 \partial_\beta \omega_{\alpha\chi\delta} - 2 \partial_\beta \omega_{\alpha\delta\chi} + 2 \partial_\beta \omega_{\chi\delta\alpha} - \partial_\chi \omega_{\alpha\beta\delta} + \partial_\delta \omega_{\alpha\beta\chi} - 2 \partial_\delta \omega_{\alpha\chi\beta}) \partial^\delta \omega^{\alpha\beta\chi} \big) [t, x, y, z] dz dy dx dt$$

$\omega^{#1}_1{}^+ + \alpha\beta$	$\omega^{#1}_1{}^+ \alpha\beta$	$\omega^{#2}_1{}^+ \alpha\beta$	$f^{#1}_1{}^+ \alpha\beta$	$\omega^{#1}_1{}^- \alpha$	$\omega^{#2}_1{}^- \alpha$	$f^{#1}_1{}^- \alpha$	$f^{#2}_1{}^- \alpha$
0	0	0	0	0	0	0	0
$\omega^{#2}_1{}^+ \alpha\beta$	0	0	0	0	0	0	0
$f^{#1}_1{}^+ \alpha\beta$	0	0	0	0	0	0	0
$\omega^{#1}_1{}^- \alpha$	0	0	0	0	0	0	0
$\omega^{#2}_1{}^- \alpha$	0	0	0	0	0	0	0
$f^{#1}_1{}^- \alpha$	0	0	0	0	0	0	0
$f^{#2}_1{}^- \alpha$	0	0	0	0	0	0	0

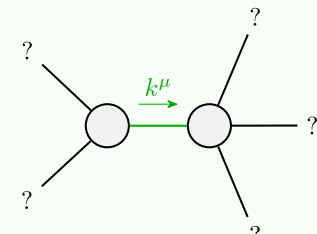
$\sigma^{#1}_1{}^+ \alpha\beta$	$\sigma^{#2}_1{}^+ \alpha\beta$	$\tau^{#1}_1{}^+ \alpha\beta$	$\sigma^{#1}_1{}^- \alpha$	$\sigma^{#2}_1{}^- \alpha$	$\tau^{#1}_1{}^- \alpha$	$\tau^{#2}_1{}^- \alpha$
0	0	0	0	0	0	0
$\sigma^{#2}_1{}^+ \alpha\beta$	0	0	0	0	0	0
$\tau^{#1}_1{}^+ \alpha\beta$	0	0	0	0	0	0
$\sigma^{#1}_1{}^- \alpha$	0	0	0	0	0	0
$\sigma^{#2}_1{}^- \alpha$	0	0	0	0	0	0
$\tau^{#1}_1{}^- \alpha$	0	0	0	0	0	0
$\tau^{#2}_1{}^- \alpha$	0	0	0	0	0	0

$\sigma^{#1}_2{}^+ \alpha\beta$	$\tau^{#1}_2{}^+ \alpha\beta$	$\sigma^{#2}_2{}^- \alpha\beta\chi$
0	0	0
$\tau^{#1}_2{}^+ \alpha\beta$	0	$\frac{1}{2\beta_1 k^2}$
$\sigma^{#1}_2{}^- \alpha\beta\chi$	0	0

$\omega^{#1}_0{}^+ \dagger$	$f^{#1}_0{}^+ \dagger$	$f^{#2}_0{}^+ \dagger$	$\omega^{#1}_0{}^- \dagger$
0	0	0	0
$f^{#1}_0{}^+ \dagger$	-4 $\beta_1 k^2$	0	0
$f^{#2}_0{}^+ \dagger$	0	0	0
$\omega^{#1}_0{}^- \dagger$	0	0	$\alpha_3 k^2$

$\omega^{#1}_2{}^+ \dagger \alpha\beta$	$f^{#1}_2{}^+ \dagger \alpha\beta$	$\omega^{#1}_2{}^- \dagger \alpha\beta\chi$
0	0	0
$f^{#1}_2{}^+ \dagger \alpha\beta$	2 $\beta_1 k^2$	0
$\omega^{#1}_2{}^- \dagger \alpha\beta\chi$	0	0

Massive and massless spectra



Quadratic pole

Pole residue: $\frac{1}{\beta_1} > 0$

Polarisations: 2

(No massive particles)

Unitarity conditions

$\beta_1 > 0$