Particle spectrograph

Wave operator and propagator

	$\Delta^{\#1}_{1^{+}\,\alpha\beta}$	$\Delta^{\#2}_{1^{+}\,\alpha\beta}$	$\Delta^{\#3}_{1^{+}\,\alpha\beta}$	$\Delta^{\#1}_{1^{-}\,\alpha}$	$\Delta^{\#2}_{1^{-}\,\alpha}$	$\Delta^{\#3}_{1^{-}\,\alpha}$	$\Delta^{\#4}_{1^{-}\,\alpha}$	$\Delta^{\#5}_{1^{-}\,\alpha}$	$\Delta^{\#6}_{1^{-}\,\alpha}$	$\mathcal{T}^{\#1}_{1^{-}\,\alpha}$
$\Delta^{\#1}_{1^{+}}{}^{\dagger\alpha\beta}$	0	$-\frac{2\sqrt{2}}{a_0}$	0	0	0	0	0	0	0	0
$\Delta^{\#2}_{1^{+}}{}^{\dagger\alpha\beta}$	$-\frac{2\sqrt{2}}{a_0}$	$\frac{2}{a_0}$	0	0	0	0	0	0	0	0
$\Delta^{\#3}_{1^{+}}{}^{\dagger\alpha\beta}$	0	0	$\frac{4}{a_0}$	0	0	0	0	0	0	0
$\Delta^{\#1}_{1^{-}}{}^{\dagger\alpha}$	0	0	0	0	$\frac{2\sqrt{2}}{a_0}$	0	0	0	0	0
$\Delta^{\#2}_{1^{-}}{}^{\dagger\alpha}$	0	0	0	$\frac{2\sqrt{2}}{a_0}$	$\frac{2}{a_0}$	0	0	0	0	0
$\Delta^{\#3}_{1^{-}}{}^{\dagger\alpha}$	0	0	0	0	0	$-\frac{19}{12 a_0}$	$\frac{5\sqrt{5}}{12 a_0}$	$-\frac{1}{6\sqrt{2}\,a_0}$	$-\frac{1}{6 a_0}$	0
$\Delta^{\#4}_{1^{-}}{}^{\dagger\alpha}$	0	0	0	0	0	$\frac{5\sqrt{5}}{12 a_0}$	$\frac{1}{12 a_0}$	$-\frac{\sqrt{\frac{5}{2}}}{6 a_0}$	$-\frac{\sqrt{5}}{6 a_0}$	0
$\Delta^{\#5}_{1^{-}}{}^{\dagger\alpha}$	0	0	0	0	0	$-\frac{1}{6\sqrt{2}\,a_0}$	$-\frac{\sqrt{\frac{5}{2}}}{6 a_0}$	$\frac{17}{6 a_0}$	$-\frac{7}{3\sqrt{2}\,a_0}$	0
$\Delta^{\#6}_{1^{-}}{}^{\dagger\alpha}$	0	0	0	0	0	$-\frac{1}{6 a_0}$	$-\frac{\sqrt{5}}{6 a_0}$	$-\frac{7}{3\sqrt{2}\,a_0}$	$\frac{5}{3 a_0}$	0
$\mathcal{T}^{\#1}_{1^{-}}{}^{\dagger\alpha}$	0	0	0	0	0	0	0	0	0	0

	$\mathcal{A}^{\#1}_{1^{+}\,\alpha\beta}$	$\mathcal{A}^{\#2}_{1^{+}\,\alpha\beta}$	$\mathcal{A}^{\#3}_{1^{+}\,\alpha\beta}$	$\mathcal{A}^{\#1}_{1^{-}\,\alpha}$	$\mathcal{A}^{\#2}_{1^{-}\,\alpha}$	$\mathcal{A}^{\#3}_{1^{-}\,\alpha}$	$\mathcal{A}^{\#4}_{1^{-}\,\alpha}$	$\mathcal{A}^{\#5}_{1^{-}\,\alpha}$	$\mathcal{A}^{\#6}_{1^{-}\,\alpha}$	$h^{\#1}_{1^{-}\,\alpha}$
$\mathcal{A}^{\#1}_{1^{+}}{}^{\dagger\alpha\beta}$	$-\frac{a_0}{4}$	$-\frac{a_0}{2\sqrt{2}}$	0	0	0	0	0	0	0	0
$\mathcal{A}^{\#2}_{1^{+}}{}^{\dagger\alpha\beta}$	$-\frac{a_0}{2\sqrt{2}}$	0	0	0	0	0	0	0	0	0
$\mathcal{A}^{\#3}_{1^{+}}{}^{\dagger\alpha\beta}$	0	0	$\frac{a_0}{4}$	0	0	0	0	0	0	0
$\mathcal{A}^{\#1}_{1^{-}}{}^{\dagger\alpha}$	0	0	0	$-\frac{a_0}{4}$	$\frac{a_0}{2\sqrt{2}}$	0	0	0	0	0
$\mathcal{A}^{\#2}_{1^{-}}{}^{\dagger\alpha}$	0	0	0	$\frac{a_0}{2\sqrt{2}}$	0	0	0	0	0	0
$\mathcal{A}^{\#3}_{1^{-}}{}^{\dagger\alpha}$	0	0	0	0	0	$-\frac{a_0}{3}$	$\frac{\sqrt{5}\,a_0}{6}$	$-\frac{a_0}{6\sqrt{2}}$	$-\frac{a_0}{6}$	0
$\mathcal{A}^{\#4}_{1^{-}}{}^{\dagger\alpha}$	0	0	0	0	0	$\frac{\sqrt{5}\,a_0}{6}$	$\frac{a_0}{3}$	$-\frac{1}{6}\sqrt{\frac{5}{2}}\,a_0$	$-\frac{\sqrt{5}\,a_0}{6}$	0
$\mathcal{A}^{\#5}_{1^{-}}{}^{\dagger\alpha}$	0	0	0	0	0	$-\frac{a_0}{6\sqrt{2}}$	$-\frac{1}{6}\sqrt{\frac{5}{2}}\,a_0$	$\frac{a_0}{3}$	$\frac{a_0}{6\sqrt{2}}$	0
$\mathcal{A}^{\#6}_{1^{-}}{}^{\dagger\alpha}$	0	0	0	0	0	$-\frac{a_0}{6}$	$-\frac{\sqrt{5}\,a_0}{6}$	$\frac{a_0}{6\sqrt{2}}$	$\frac{5 a_0}{12}$	0
$h^{\#1}_{1^{-}}{}^{\dagger\alpha}$	0	0	0	0	0	0	0	0	0	0

Quadratic (free) action

$$S == \iiiint\Big(\tfrac{1}{8}\big(8\,h^{\alpha\beta}\,\mathcal{T}_{\alpha\beta} - 4\,\mathcal{A}^{\alpha\beta\chi}\,(a_0\,\mathcal{A}_{\beta\chi\alpha} - 2\,\Delta_{\alpha\beta\chi} + a_0\,\partial_{\beta}h_{\alpha\chi}) +$$
$$2\,a_0\,\mathcal{A}^{\alpha\beta}{}_{\alpha}\,\partial_{\beta}h^{\chi}{}_{\chi} - 2\,a_0\,h^{\chi}{}_{\chi}\,\partial_{\beta}\mathcal{A}^{\alpha}{}_{\alpha}{}^{\beta} + 2\,a_0\,h^{\chi}{}_{\chi}\,\partial_{\beta}\mathcal{A}^{\alpha\beta}{}_{\alpha} -$$
$$4\,a_0\,h_{\alpha\chi}\,\partial_{\beta}\mathcal{A}^{\alpha\beta\chi} + 4\,a_0\,h^{\alpha\beta}\,\partial_{\beta}\partial_{\alpha}h^{\chi}{}_{\chi} - a_0\,\partial_{\beta}h^{\chi}{}_{\chi}\,\partial^{\beta}h^{\alpha}{}_{\alpha} -$$
$$4\,a_0\,\partial_{\alpha}h^{\alpha\beta}\,\partial_{\chi}h_{\beta}{}^{\chi} + 4\,a_0\,\partial^{\beta}h^{\alpha}{}_{\alpha}\,\partial_{\chi}h_{\beta}{}^{\chi} + 2\,a_0\,\mathcal{A}^{\alpha}{}_{\alpha}{}^{\beta}$$
$$(2\,\mathcal{A}^{\chi}{}_{\beta\chi} - \partial_{\beta}h^{\chi}{}_{\chi} + 2\,\partial_{\chi}h_{\beta}{}^{\chi}) - 8\,a_0\,h^{\alpha\beta}\,\partial_{\chi}\partial_{\beta}h_{\alpha}{}^{\chi} +$$
$$2\,a_0\,h^{\alpha}{}_{\alpha}\,\partial_{\chi}\partial_{\beta}h^{\beta\chi} + 4\,a_0\,h^{\alpha\beta}\,\partial_{\chi}\partial^{\chi}h_{\alpha\beta} - 2\,a_0\,h^{\alpha}{}_{\alpha}\,\partial_{\chi}\partial^{\chi}h^{\beta}{}_{\beta} -$$
$$2\,a_0\,\partial_{\beta}h_{\alpha\chi}\,\partial^{\chi}h^{\alpha\beta} + 3\,a_0\,\partial_{\chi}h_{\alpha\beta}\,\partial^{\chi}h^{\alpha\beta} +$$
$$4\,a_0\,h_{\beta\chi}\,\partial^{\chi}\mathcal{A}^{\alpha}{}_{\alpha}{}^{\beta}\big)\Big)[t, x, y, z]\,dz\,dy\,dx\,dt$$

Source constraints

SO(3) irreps	Fundamental fields	Multiplicities
$\mathcal{T}^{\#2}_{0^{+}} == 0$	$\partial_{\beta}\partial_{\alpha}\mathcal{T}^{\alpha\beta} == 0$	1
$\Delta^{\#3}_{0^{+}} + 2\,\Delta^{\#4}_{0^{+}} + 3\,\Delta^{\#2}_{0^{+}} == 0$	$\partial_{\alpha}\Delta^{\alpha\beta}{}_{\beta} == 0$	1
$\mathcal{T}^{\#1}_{1^{-}}{}^{\alpha} == 0$	$\partial_{\chi}\partial_{\beta}\partial^{\alpha}\mathcal{T}^{\beta\chi} == \partial_{\chi}\partial^{\chi}\partial_{\beta}\mathcal{T}^{\alpha\beta}$	3
$2\,\Delta^{\#6}_{1^{-}}{}^{\alpha} + \Delta^{\#4}_{1^{-}}{}^{\alpha} + 2\,\Delta^{\#5}_{1^{-}}{}^{\alpha} + \Delta^{\#3}_{1^{-}}{}^{\alpha} == 0$	$\partial_{\beta}\partial^{\alpha}\Delta^{\beta\chi}{}_{\chi} == \partial_{\chi}\partial^{\chi}\Delta^{\alpha\beta}{}_{\beta}$	3
Total constraints/gauge generators:		8

	$\Delta^{\#1}_{3^{-}\,\alpha\beta\chi}$
$\Delta^{\#1}_{3^{-}}{}^{\dagger\alpha\beta\chi}$	$-\frac{2}{a_0}$

	$\mathcal{A}^{\#1}_{3^{-}\,\alpha\beta\chi}$
$\mathcal{A}^{\#1}_{3^{-}}{}^{\dagger\alpha\beta\chi}$	$-\frac{a_0}{2}$

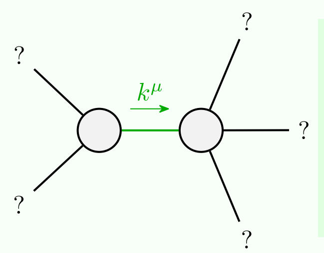
	$\Delta^{\#1}_{0^{+}}$	$\Delta^{\#2}_{0^{+}}$	$\Delta^{\#3}_{0^{+}}$	$\Delta^{\#4}_{0^{+}}$	$\mathcal{T}^{\#1}_{0^{+}}$	$\mathcal{T}^{\#2}_{0^{+}}$	$\Delta^{\#1}_{0^{-}}$
$\Delta^{\#1}_{0^{+}}{}^{\dagger}$	$-\frac{2}{a_0}$	0	0	0	0	0	0
$\Delta^{\#2}_{0^{+}}{}^{\dagger}$	0	$-\frac{3}{4 a_0}$	$\frac{5}{4 a_0}$	$-\frac{1}{2\sqrt{2}\,a_0}$	0	0	0
$\Delta^{\#3}_{0^{+}}{}^{\dagger}$	0	$\frac{5}{4 a_0}$	$-\frac{3}{4 a_0}$	$-\frac{1}{2\sqrt{2}\,a_0}$	0	0	0
$\Delta^{\#4}_{0^{+}}{}^{\dagger}$	0	$-\frac{1}{2\sqrt{2}\,a_0}$	$-\frac{1}{2\sqrt{2}\,a_0}$	$\frac{1}{2 a_0}$	0	0	0
$\mathcal{T}^{\#1}_{0^{+}}{}^{\dagger}$	0	0	0	0	$\frac{4}{a_0 k^2}$	0	0
$\mathcal{T}^{\#2}_{0^{+}}{}^{\dagger}$	0	0	0	0	0	0	0
$\Delta^{\#1}_{0^{-}}{}^{\dagger}$	0	0	0	0	0	0	$-\frac{2}{a_0}$

	$\Delta^{\#1}_{2^{+}\,\alpha\beta}$	$\Delta^{\#2}_{2^{+}\,\alpha\beta}$	$\Delta^{\#3}_{2^{+}\,\alpha\beta}$	$\mathcal{T}^{\#1}_{2^{+}\,\alpha\beta}$	$\Delta^{\#1}_{2^{-}\,\alpha\beta\chi}$	$\Delta^{\#2}_{2^{-}\,\alpha\beta\chi}$
$\Delta^{\#1}_{2^{+}}{}^{\dagger\alpha\beta}$	$\frac{4}{a_0}$	0	0	0	0	0
$\Delta^{\#2}_{2^{+}}{}^{\dagger\alpha\beta}$	0	$-\frac{2}{a_0}$	0	0	0	0
$\Delta^{\#3}_{2^{+}}{}^{\dagger\alpha\beta}$	0	0	$\frac{4}{a_0}$	0	0	0
$\mathcal{T}^{\#1}_{2^{+}}{}^{\dagger\alpha\beta}$	0	0	0	$-\frac{8}{a_0 k^2}$	0	0
$\Delta^{\#1}_{2^{-}}{}^{\dagger\alpha\beta\chi}$	0	0	0	0	$\frac{4}{a_0}$	0
$\Delta^{\#2}_{2^{-}}{}^{\dagger\alpha\beta\chi}$	0	0	0	0	0	$\frac{4}{a_0}$

	$\mathcal{A}^{\#1}_{0^{+}}$	$\mathcal{A}^{\#2}_{0^{+}}$	$\mathcal{A}^{\#3}_{0^{+}}$	$\mathcal{A}^{\#4}_{0^{+}}$	$h^{\#1}_{0^{+}}$	$h^{\#2}_{0^{+}}$	$\mathcal{A}^{\#1}_{0^{-}}$
$\mathcal{A}^{\#1}_{0^{+}}{}^{\dagger}$	$-\frac{a_0}{2}$	0	0	0	0	0	0
$\mathcal{A}^{\#2}_{0^{+}}{}^{\dagger}$	0	0	$\frac{a_0}{2}$	$-\frac{a_0}{2\sqrt{2}}$	0	0	0
$\mathcal{A}^{\#3}_{0^{+}}{}^{\dagger}$	0	$\frac{a_0}{2}$	0	$-\frac{a_0}{2\sqrt{2}}$	0	0	0
$\mathcal{A}^{\#4}_{0^{+}}{}^{\dagger}$	0	$-\frac{a_0}{2\sqrt{2}}$	$-\frac{a_0}{2\sqrt{2}}$	$\frac{a_0}{2}$	0	0	0
$h^{\#1}_{0^{+}}{}^{\dagger}$	0	0	0	0	$\frac{a_0 k^2}{4}$	0	0
$h^{\#2}_{0^{+}}{}^{\dagger}$	0	0	0	0	0	0	0
$\mathcal{A}^{\#1}_{0^{-}}{}^{\dagger}$	0	0	0	0	0	0	$-\frac{a_0}{2}$

	$\mathcal{A}^{\#1}_{2^{+}\,\alpha\beta}$	$\mathcal{A}^{\#2}_{2^{+}\,\alpha\beta}$	$\mathcal{A}^{\#3}_{2^{+}\,\alpha\beta}$	$h^{\#1}_{2^{+}\,\alpha\beta}$	$\mathcal{A}^{\#1}_{2^{-}\,\alpha\beta\chi}$	$\mathcal{A}^{\#2}_{2^{-}\,\alpha\beta\chi}$
$\mathcal{A}^{\#1}_{2^{+}}{}^{\dagger\alpha\beta}$	$\frac{a_0}{4}$	0	0	0	0	0
$\mathcal{A}^{\#2}_{2^{+}}{}^{\dagger\alpha\beta}$	0	$-\frac{a_0}{2}$	0	0	0	0
$\mathcal{A}^{\#3}_{2^{+}}{}^{\dagger\alpha\beta}$	0	0	$\frac{a_0}{4}$	0	0	0
$h^{\#1}_{2^{+}}{}^{\dagger\alpha\beta}$	0	0	0	$-\frac{a_0 k^2}{8}$	0	0
$\mathcal{A}^{\#1}_{2^{-}}{}^{\dagger\alpha\beta\chi}$	0	0	0	0	$\frac{a_0}{4}$	0
$\mathcal{A}^{\#2}_{2^{-}}{}^{\dagger\alpha\beta\chi}$	0	0	0	0	0	$\frac{a_0}{4}$

Massive and massless spectra



Quadratic pole	
Pole residue:	$-\frac{1}{a_0} > 0$
Polarisations:	2

(No massive particles)

Unitarity conditions

$a_0 < 0$