Particle spectrograph

Wave operator and propagator

	$\mathcal{T}^{\#1}_{1^-\,\alpha}$	$\Delta^{\#6}_{1^-\,\alpha}$	$\Delta^{\#5}_{1^-\,\alpha}$	$\Delta^{\#4}_{1^-\,\alpha}$	$\Delta^{\#3}_{1^-\,\alpha}$	$\Delta^{\#2}_{1^+\,\alpha\beta}$	$\Delta^{\#1}_{1^+\,\alpha\beta}$
$\Delta^{\#1}_{1^+\,\alpha\beta}$	$-\frac{2i\sqrt{2}\,k}{a_0(2+k^2)}$	$\frac{1}{\sqrt{6}\,a_0(2+k^2)}$	$\frac{\sqrt{2}\,k^2}{a_0(2+k^2)}$	0	$-\frac{2k^2}{\sqrt{3}\,a_0(2+k^2)}$	$-\frac{2\sqrt{2}}{a_0}$	0
$\Delta^{\#2}_{1^+\,\alpha\beta}$	$-\frac{ik(4+k^2)}{a_0(2+k^2)^2}$	$-\frac{8a_0}{2+3k^2}$	$\frac{\sqrt{2}\,(4+k^2)}{a_0(2+k^2)}$	$-\frac{\sqrt{6}}{4a_0+2a_0k^2}$	$\frac{k^2(-2+k^2)}{2\sqrt{6}\,a_0(2+k^2)^2}$	$\frac{2}{a_0}$	0
$\Delta^{\#3}_{1^+\,\alpha\beta}$	$\frac{ik(6+5k^2)}{\sqrt{6}\,a_0(2+k^2)^2}$	$-2a_0\frac{1}{2+3k^2}$	$\frac{(4+k^2)^2}{2a_0(2+k^2)^2}$	$\frac{\sqrt{6}}{4a_0+2a_0k^2}$	$-\frac{76+52k^2+3k^4}{12a_0(2+k^2)^2}$	$-\frac{2\sqrt{2}}{a_0}$	0
$\Delta^{\#1}_{1^-\,\alpha}$	$\frac{i\sqrt{6}\,k}{a_0(2+k^2)}$	$-\frac{\sqrt{6}}{6a_0}$	$\frac{k^2(5+2k^2)}{\sqrt{3}\,a_0(2+k^2)^2}$	$\frac{\sqrt{5}\,(10+3k^2)}{12a_0(2+k^2)}$	$\frac{\sqrt{5}\,(10+3k^2)}{12a_0(2+k^2)}$	0	0
$\Delta^{\#2}_{1^-\,\alpha}$	$\frac{i\sqrt{3}\,k}{a_0(2+k^2)}$	$-\frac{\sqrt{5}}{6a_0}$	$\frac{\sqrt{5}}{6a_0+3a_0k^2}$	$\frac{1}{12a_0}$	$-\frac{-2+k^2}{3\sqrt{2}\,a_0(2+k^2)^2}$	0	0
$\Delta^{\#3}_{1^-\,\alpha}$	$\frac{2k^2}{a_0(2+k^2)^2}$	$\frac{\sqrt{2}}{3a_0+a_0k^2}$	$-\frac{\sqrt{2}\,(7+3k^2)}{3a_0(2+k^2)}$	$\frac{\sqrt{5}}{6a_0+3a_0k^2}$	$-\frac{1}{\sqrt{2}\,a_0(2+k^2)^2}$	0	0
$\Delta^{\#4}_{1^-\,\alpha}$	$\frac{i\sqrt{3}\,k}{2a_0+a_0k^2}$	$\frac{5}{3a_0}$	$\frac{\sqrt{2}\,(3+k^2)}{3a_0(2+k^2)^2}$	$-\frac{\sqrt{5}}{6a_0}$	$\frac{2ik(3+k^2)}{\sqrt{3}\,a_0(2+k^2)^2}$	0	0
$\Delta^{\#5}_{1^-\,\alpha}$	$\frac{2k^2}{a_0(2+k^2)^2}$	$\frac{i\sqrt{2}\,k}{2a_0+a_0k^2}$	$\frac{5}{3a_0}$	$\frac{i\sqrt{5}\,k}{2a_0+a_0k^2}$	$-\frac{2ik(3+k^2)}{\sqrt{3}\,a_0(2+k^2)^2}$	0	0
$\Delta^{\#6}_{1^-\,\alpha}$	$\frac{ik(4+k^2)}{a_0(2+k^2)^2}$	$-\frac{k^2}{\sqrt{6}\,a_0(2+k^2)^2}$	$\frac{\sqrt{2}\,(7+3k^2)}{3a_0(2+k^2)^2}$	$\frac{i\sqrt{6}\,k}{2a_0+a_0k^2}$	$-\frac{ik(6+5k^2)}{\sqrt{6}\,a_0(2+k^2)^2}$	$-\frac{2i\sqrt{2}\,k}{a_0(2+k^2)}$	0
$\Delta^{\#1}_{1^+\,\alpha}$	0	0	0	0	0	0	0
$\Delta^{\#2}_{1^+\,\alpha}$	0	0	0	0	0	0	0
$\Delta^{\#3}_{1^+\,\alpha}$	0	0	0	0	0	0	0

$\Delta^{\#1}_{3^-\,\alpha\beta\chi}$

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

$\Gamma^{\#1}_{3^-\,\alpha\beta\chi}$

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

	$\Delta^{\#1}_{0^+}$	$\Delta^{\#2}_{0^+}$	$\Delta^{\#3}_{0^+}$	$\Delta^{\#4}_{0^+}$	$\mathcal{T}^{\#1}_{0^+}$	$\mathcal{T}^{\#2}_{0^+}$	$\Delta^{\#1}_{0^-}$
$\Delta^{\#1}_{0^+}\dagger$	0	$\frac{4\sqrt{6}}{16a_0+3a_0k^2}$	$-\frac{4\sqrt{\frac{2}{3}}}{16a_0+3a_0k^2}$	$-\frac{8}{\sqrt{3}\,(16a_0+3a_0k^2)}$	$-\frac{2i\sqrt{2}}{a_0k}$	$-\frac{2i\sqrt{6}\,k}{16a_0+3a_0k^2}$	$-\frac{2}{a_0}$
$\Delta^{\#2}_{0^+}\dagger$	$\frac{4\sqrt{6}}{16a_0+3a_0k^2}$	$-\frac{144}{a_0(16+3k^2)^2}$	$\frac{16(19+3k^2)}{a_0(16+3k^2)^2}$	$-\frac{8\sqrt{2}\,(10+3k^2)}{a_0(16+3k^2)^2}$	$-\frac{8i\sqrt{3}}{16a_0+3a_0k^2}$	$\frac{72ik}{a_0(16+3k^2)^2}$	0
$\Delta^{\#3}_{0^+}\dagger$	$-\frac{4\sqrt{\frac{2}{3}}}{16a_0+3a_0k^2}$	$\frac{16(19+3k^2)}{a_0(16+3k^2)^2}$	$-\frac{16(35+6k^2)}{3a_0(16+3k^2)^2}$	$\frac{8\sqrt{2}\,(22+3k^2)}{3a_0(16+3k^2)^2}$	$\frac{8i}{\sqrt{3}\,(16a_0+3a_0k^2)}$	$-\frac{8ik(19+3k^2)}{a_0(16+3k^2)^2}$	0
$\Delta^{\#4}_{0^+}\dagger$	$-\frac{8}{\sqrt{3}\,(16a_0+3a_0k^2)}$	$\frac{8\sqrt{2}\,(10+3k^2)}{a_0(16+3k^2)^2}$	$-\frac{8\sqrt{2}\,(22+3k^2)}{3a_0(16+3k^2)^2}$	$\frac{32(13+3k^2)}{3a_0(16+3k^2)^2}$	$-\frac{8i}{\sqrt{3}\,(16a_0+3a_0k^2)}$	$\frac{4i\sqrt{2}\,k(10+3k^2)}{a_0(16+3k^2)^2}$	0
$\mathcal{T}^{\#1}_{0^+}\dagger$	$\frac{2i\sqrt{2}}{a_0k}$	$\frac{72ik}{a_0(16+3k^2)^2}$	$-\frac{8i(19+3k^2)}{a_0(16+3k^2)^2}$	$\frac{8i\sqrt{\frac{2}{3}}}{16a_0+3a_0k^2}$	$\frac{4}{a_0k^2}$	$\frac{4\sqrt{3}}{16a_0+3a_0k^2}$	0
$\mathcal{T}^{\#2}_{0^+}\dagger$	$\frac{2i\sqrt{6}\,k}{16a_0+3a_0k^2}$	$-\frac{72ik}{a_0(16+3k^2)^2}$	$\frac{8ik(19+3k^2)}{a_0(16+3k^2)^2}$	$-\frac{4i\sqrt{2}\,k(10+3k^2)}{a_0(16+3k^2)^2}$	$\frac{4\sqrt{3}}{16a_0+3a_0k^2}$	$-\frac{36k^2}{a_0(16+3k^2)^2}$	$\frac{2}{a_0}$
$\Delta^{\#1}_{0^-}\dagger$	0	0	0	0	0	0	0

Source constraints/gauge generators

SO(3) irreps	Multiplicities
$2\,\mathcal{T}^{\#2}_{0^+} - i\,k\,\Delta^{\#2}_{0^+} == 0$	1
$\Delta^{\#3}_{0^+} + 2\,\Delta^{\#4}_{0^+} + 3\,\Delta^{\#2}_{0^+} == 0$	1
$6\,\mathcal{T}^{\#1\,\alpha}_{1^-} - i\,k\,(3\,\Delta^{\#2\,\alpha}_{1^-} - \Delta^{\#5\,\alpha}_{1^-} + \Delta^{\#3\,\alpha}_{1^-}) == 0$	3
$2\,\Delta^{\#6\,\alpha}_{1^-} + \Delta^{\#4\,\alpha}_{1^-} + 2\,\Delta^{\#5\,\alpha}_{1^-} + \Delta^{\#3\,\alpha}_{1^-} == 0$	3
Total constraints:	8

Quadratic (free) action

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

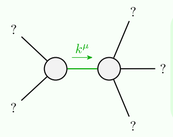
	$h^{\#1}_{1^-\,\alpha}$	$\Gamma^{\#6}_{1^-\,\alpha}$	$\Gamma^{\#5}_{1^-\,\alpha}$	$\Gamma^{\#4}_{1^-\,\alpha}$	$\Gamma^{\#3}_{1^-\,\alpha}$	$\Gamma^{\#2}_{1^+\,\alpha\beta}$	$\Gamma^{\#1}_{1^+\,\alpha\beta}$
$\Gamma^{\#1}_{1^+\,\alpha\beta}\dagger^{\alpha\beta}$	0	0	0	0	0	$-\frac{a_0}{2\sqrt{2}}$	$-\frac{a_0}{4}$
$\Gamma^{\#2}_{1^+\,\alpha\beta}\dagger^{\alpha\beta}$	0	0	0	0	0	0	$-\frac{a_0}{2\sqrt{2}}$
$\Gamma^{\#3}_{1^+\,\alpha\beta}\dagger^{\alpha\beta}$	0	0	0	0	$\frac{a_0}{4}$	0	0
$\Gamma^{\#1}_{1^-\,\alpha}\dagger^{\alpha}$	$-\frac{ia_0k}{4\sqrt{2}}$	0	0	0	0	$\frac{a_0}{2\sqrt{2}}$	$-\frac{a_0}{4}$
$\Gamma^{\#2}_{1^-\,\alpha}\dagger^{\alpha}$	0	0	0	0	0	0	$\frac{a_0}{2\sqrt{2}}$
$\Gamma^{\#3}_{1^-\,\alpha}\dagger^{\alpha}$	$\frac{ia_0k}{4\sqrt{6}}$	$-\frac{a_0}{6}$	$-\frac{a_0}{6\sqrt{2}}$	$\frac{\sqrt{5}\,a_0}{6}$	0	0	0
$\Gamma^{\#4}_{1^-\,\alpha}\dagger^{\alpha}$	$-\frac{1}{4}i\sqrt{\frac{5}{6}}\,a_0\,k$	$-\frac{\sqrt{5}\,a_0}{6}$	$\frac{1}{6}\sqrt{\frac{5}{2}}\,a_0$	$-\frac{a_0}{3}$	0	0	0
$\Gamma^{\#5}_{1^-\,\alpha}\dagger^{\alpha}$	$\frac{ia_0k}{4\sqrt{3}}$	$\frac{a_0}{6\sqrt{2}}$	$-\frac{a_0}{3}$	0	0	0	0
$\Gamma^{\#6}_{1^-\,\alpha}\dagger^{\alpha}$	$\frac{ia_0k}{4\sqrt{6}}$	$\frac{5a_0}{12}$	$\frac{a_0}{6\sqrt{2}}$	$-\frac{\sqrt{5}\,a_0}{6}$	$-\frac{a_0}{6\sqrt{2}}$	$\frac{a_0}{6\sqrt{2}}$	$\frac{a_0}{6\sqrt{2}}$
$h^{\#1}_{1^+}\dagger^{\alpha}$	0	$-\frac{ia_0k}{4\sqrt{6}}$	$-\frac{ia_0k}{4\sqrt{3}}$	$\frac{1}{6}i\sqrt{\frac{5}{6}}\,a_0\,k$	$\frac{ia_0k}{4\sqrt{6}}$	$\frac{ia_0k}{4\sqrt{3}}$	$\frac{ia_0k}{4\sqrt{2}}$

	$\Delta^{\#1}_{2^+\,\alpha\beta}$	$\Delta^{\#2}_{2^+\,\alpha\beta}$	$\Delta^{\#3}_{2^+\,\alpha\beta}$	$\mathcal{T}^{\#1}_{2^+\,\alpha\beta}$	$\Delta^{\#1}_{2^-\,\alpha\beta\chi}$	$\Delta^{\#2}_{2^-\,\alpha\beta\chi}$
$\Delta^{\#1}_{2^+\,\alpha\beta}\dagger^{\alpha\beta}$	0	$\frac{2\sqrt{\frac{2}{3}}}{a_0}$	$\frac{4}{\sqrt{3}\,a_0}$	$\frac{4i\sqrt{2}}{a_0k}$	0	0
$\Delta^{\#2}_{2^+\,\alpha\beta}\dagger^{\alpha\beta}$	$\frac{2\sqrt{\frac{2}{3}}}{a_0}$	$-\frac{8}{3a_0}$	$-\frac{2\sqrt{2}}{3a_0}$	$-\frac{4i}{\sqrt{3}\,a_0k}$	0	0
$\Delta^{\#3}_{2^+\,\alpha\beta}\dagger^{\alpha\beta}$	$\frac{4}{\sqrt{3}\,a_0}$	$-\frac{2\sqrt{2}}{3a_0}$	$\frac{8}{3a_0}$	$-\frac{4i\sqrt{\frac{2}{3}}}{a_0k}$	0	0
$\mathcal{T}^{\#1}_{2^+\,\alpha\beta}\dagger^{\alpha\beta}$	$\frac{4i\sqrt{2}}{a_0k}$	$-\frac{4i}{\sqrt{3}\,a_0k}$	$\frac{4i\sqrt{\frac{2}{3}}}{a_0k}$	$-\frac{8}{a_0k^2}$	0	0
$\Delta^{\#1}_{2^-\,\alpha\beta\chi}\dagger^{\alpha\beta\chi}$	0	0	0	0	0	$\frac{4}{a_0}$
$\Delta^{\#2}_{2^-\,\alpha\beta\chi}\dagger^{\alpha\beta\chi}$	0	0	0	0	$\frac{4}{a_0}$	0

	$\Gamma^{\#1}_{2^+\,\alpha\beta}$	$\Gamma^{\#2}_{2^+\,\alpha\beta}$	$\Gamma^{\#3}_{2^+\,\alpha\beta}$	$h^{\#1}_{2^+\,\alpha\beta}$	$\Gamma^{\#1}_{2^-\,\alpha\beta\chi}$	$\Gamma^{\#2}_{2^-\,\alpha\beta\chi}$
$\Gamma^{\#1}_{2^+\,\alpha\beta}\dagger^{\alpha\beta}$	$\frac{a_0}{4}$	0	0	$\frac{ia_0k}{4\sqrt{2}}$	0	0
$\Gamma^{\#2}_{2^+\,\alpha\beta}\dagger^{\alpha\beta}$	0	$-\frac{a_0}{2}$	0	$\frac{ia_0k}{4\sqrt{3}}$	0	0
$\Gamma^{\#3}_{2^+\,\alpha\beta}\dagger^{\alpha\beta}$	0	0	$\frac{a_0}{4}$	$-\frac{ia_0k}{4\sqrt{6}}$	0	0
$h^{\#1}_{2^+}\dagger^{\alpha\beta}$	$-\frac{ia_0k}{4\sqrt{2}}$	$-\frac{ia_0k}{4\sqrt{3}}$	$\frac{ia_0k}{4\sqrt{6}}$	0	0	0
$\Gamma^{\#1}_{2^-\,\alpha\beta\chi}\dagger^{\alpha\beta\chi}$	0	0	0	0	$\frac{a_0}{4}$	0
$\Gamma^{\#2}_{2^-\,\alpha\beta\chi}\dagger^{\alpha\beta\chi}$	0	0	0	0	0	$\frac{a_0}{4}$

	$\Gamma^{\#1}_{0^+\,\alpha}$	$\Gamma^{\#2}_{0^+\,\alpha}$	$\Gamma^{\#3}_{0^+\,\alpha}$	$\Gamma^{\#4}_{0^+\,\alpha}$	$h^{\#1}_{0^+\,\alpha}$	$h^{\#2}_{0^+\,\alpha}$	$\Gamma^{\#1}_{0^-\,\alpha}$
$\Gamma^{\#1}_{0^+\,\alpha}\dagger$	$-\frac{a_0}{2}$	0	0	0	$-\frac{ia_0k}{2\sqrt{2}}$	0	0
$\Gamma^{\#2}_{0^+\,\alpha}\dagger$	0	0	$\frac{a_0}{2}$	$-\frac{a_0}{2\sqrt{2}}$	0	0	0
$\Gamma^{\#3}_{0^+\,\alpha}\dagger$	0	$\frac{a_0}{2}$	0	$-\frac{a_0}{2\sqrt{2}}$	$\frac{ia_0k}{4\sqrt{6}}$	$-\frac{1}{4}i\,a_0\,k$	0
$\Gamma^{\#4}_{0^+\,\alpha}\dagger$	0	$-\frac{a_0}{2\sqrt{2}}$	$-\frac{a_0}{2\sqrt{2}}$	$\frac{a_0}{2}$	$-\frac{ia_0k}{4\sqrt{6}}$	$\frac{ia_0k}{4\sqrt{2}}$	0
$h^{\#1}_{0^+\,\alpha}\dagger$	$\frac{ia_0k}{2\sqrt{2}}$	0	$-\frac{ia_0k}{4\sqrt{3}}$	$\frac{ia_0k}{4\sqrt{6}}$	0	0	0
$h^{\#2}_{0^+\,\alpha}\dagger$	0	0	$\frac{ia_0k}{4}$	$-\frac{ia_0k}{4\sqrt{2}}$	0	0	0
$\Gamma^{\#1}_{0^-\,\alpha}\dagger$	0	0	0	0	0	0	$-\frac{a_0}{2}$

Massive and massless spectra



Quadratic pole

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

(No massive particles)

Unitarity conditions

$a_0 < 0$