

Particle spectrograph

Wave operator and propagator

$\Delta_{1^+}^{\#1} \Delta_{1^+}^{\#2} \Delta_{1^+}^{\#3}$	$\Delta_{1^+}^{\#1} \alpha \beta$	$\Delta_{1^+}^{\#2} \alpha$	$\Delta_{1^+}^{\#3} \alpha$	$\Delta_{1^+}^{\#4} \alpha$	$\Delta_{1^+}^{\#5} \alpha$	$\Delta_{1^+}^{\#6} \alpha$	$\mathcal{T}_{1^+}^{\#1} \alpha$
$\Delta_{1^+}^{\#1} \dagger \alpha \beta$	0	$-\frac{2\sqrt{2}}{a_0}$	0	0	0	0	0
$\Delta_{1^+}^{\#2} \dagger \alpha \beta$	$-\frac{2\sqrt{2}}{a_0}$	$\frac{2}{a_0}$	0	0	0	0	0
$\Delta_{1^+}^{\#3} \dagger \alpha \beta$	0	0	$\frac{4}{a_0}$	0	0	0	0
$\Delta_{1^+}^{\#1} \dagger \alpha$	0	0	0	0	$-\frac{2k^2}{\sqrt{3} a_0 (2+k^2)}$	0	$-\frac{2i\sqrt{2} k}{a_0 (2+k^2)}$
$\Delta_{1^+}^{\#2} \dagger \alpha$	0	0	$\frac{\sqrt{2} (4+k^2)}{a_0 (2+k^2)}$	$-\frac{k^2 (-2+k^2)}{2 \sqrt{6} a_0 (2+k^2)^2}$	$\frac{k^2 (5+2k^2)}{\sqrt{3} a_0 (2+k^2)^2}$	$-\frac{k^2}{\sqrt{6} a_0 (2+k^2)}$	$-\frac{i k (4+k^2)}{a_0 (2+k^2)^2}$
$\Delta_{1^+}^{\#3} \dagger \alpha$	0	0	$-\frac{2k^2}{\sqrt{3} (2a_0+a_0 k^2)}$	$\frac{k^2 (-2+k^2)}{2 \sqrt{6} a_0 (2+k^2)^2}$	$\frac{-2+k^2}{3 \sqrt{2} a_0 (2+k^2)^2}$	$-\frac{1}{-2a_0} \frac{8a_0}{2+3k^2}$	$\frac{i k (6+5k^2)}{\sqrt{6} a_0 (2+k^2)^2}$
$\Delta_{1^+}^{\#4} \dagger \alpha$	0	0	0	$-\frac{\sqrt{5} k^2}{4a_0+2a_0 k^2}$	$-\frac{\sqrt{2} (10+3k^2)}{12a_0 (2+k^2)}$	$-\frac{\sqrt{5}}{6a_0}$	$-\frac{i \sqrt{\frac{5}{6}} k}{a_0 (2+k^2)}$
$\Delta_{1^+}^{\#5} \dagger \alpha$	0	0	$\frac{\sqrt{\frac{2}{3}} k^2}{2a_0+a_0 k^2}$	$-\frac{k^2 (5+2k^2)}{\sqrt{3} a_0 (2+k^2)^2}$	$-\frac{-2+k^2}{3 \sqrt{2} a_0 (2+k^2)^2}$	$-\frac{2 (17+14k^2+3k^4)}{3a_0 (2+k^2)^2}$	$-\frac{2ik (3+k^2)}{\sqrt{3} a_0 (2+k^2)^2}$
$\Delta_{1^+}^{\#6} \dagger \alpha$	0	0	0	$-\frac{k^2}{\sqrt{6} (2a_0+a_0 k^2)}$	$-\frac{\sqrt{2} (7+3k^2)}{3a_0 (2+k^2)}$	$\frac{5}{3a_0}$	$-\frac{i \sqrt{\frac{2}{3}} k}{a_0 (2+k^2)}$
$\mathcal{T}_{1^+}^{\#1} \dagger \alpha$	0	0	$\frac{2i \sqrt{2} k}{2a_0+a_0 k^2}$	$-\frac{ik (4+k^2)}{a_0 (2+k^2)^2}$	$-\frac{2ik (3+k^2)}{\sqrt{3} a_0 (2+k^2)^2}$	$\frac{i \sqrt{\frac{2}{3}} k}{2a_0+a_0 k^2}$	$-\frac{2k^2}{a_0 (2+k^2)^2}$

Quadratic (free) Lagrangian density

$$\begin{aligned} &-\frac{1}{2} a_0 \Gamma^{\alpha \beta \chi}_{\beta \chi \alpha} \Gamma^{\alpha}_{\alpha}{}^{\beta} \Gamma^{\chi}_{\beta \chi} + h^{\alpha \beta} \mathcal{T}_{\alpha \beta} + \Gamma^{\alpha \beta \chi}_{\alpha \beta \chi} \Delta_{\alpha \beta \chi} \\ &+\frac{1}{4} a_0 h^{\chi}_{\chi} \partial_{\beta} \Gamma^{\alpha \beta}_{\alpha}{}^{\beta} + \frac{1}{4} a_0 h^{\chi}_{\chi} \partial_{\beta} \Gamma^{\alpha \beta}_{\alpha}{}^{\beta} - \frac{1}{2} a_0 h_{\alpha \chi} \partial_{\beta} \Gamma^{\alpha \beta \chi}_{\alpha \beta \chi} + \frac{1}{2} a_0 h_{\beta \chi} \partial^{\chi} \Gamma^{\alpha}_{\alpha}{}^{\beta} \end{aligned}$$

$$\Delta_{3^+}^{\#1} \dagger \alpha \beta \chi \quad \Delta_{3^+}^{\#1} \alpha \beta \chi$$

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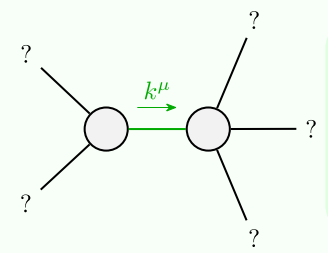
Source constraints/gauge generators	
SO(3) irreps	Multiplicities
$2 \mathcal{T}_{0^+}^{\#2} - i k \Delta_{0^+}^{\#2} == 0$	1
$\Delta_{0^+}^{\#3} + 2 \Delta_{0^+}^{\#4} + 3 \Delta_{0^+}^{\#2} == 0$	1
$6 \mathcal{T}_{1^+}^{\#1 \alpha} - i k (3 \Delta_{1^+}^{\#2 \alpha} - \Delta_{1^+}^{\#5 \alpha} + \Delta_{1^+}^{\#3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

$\Gamma_{1^+}^{\#1} \alpha \beta$	$\Gamma_{1^+}^{\#2} \alpha \beta$	$\Gamma_{1^+}^{\#3} \alpha \beta$	$\Gamma_{1^+}^{\#4} \alpha \beta$	$\Gamma_{1^+}^{\#5} \alpha \beta$	$\Gamma_{1^+}^{\#6} \alpha \beta$	$\mathcal{H}_{1^+}^{\#1} \alpha \beta$
$\Gamma_{1^+}^{\#1} \dagger \alpha \beta$	$-\frac{a_0}{4}$	0	0	0	0	0
$\Gamma_{1^+}^{\#2} \dagger \alpha \beta$	$-\frac{a_0}{2 \sqrt{2}}$	0	0	0	0	0
$\Gamma_{1^+}^{\#3} \dagger \alpha \beta$	0	$\frac{a_0}{4}$	0	0	0	0
$\Gamma_{1^+}^{\#1} \dagger \alpha$	0	$-\frac{a_0}{4}$	0	0	0	$-\frac{ia_0 k}{4 \sqrt{2}}$
$\Gamma_{1^+}^{\#2} \dagger \alpha$	0	$\frac{a_0}{2 \sqrt{2}}$	0	0	0	0
$\Gamma_{1^+}^{\#3} \dagger \alpha$	0	0	$-\frac{a_0}{3}$	$-\frac{\sqrt{5} a_0}{6}$	$-\frac{a_0}{6}$	$\frac{ia_0 k}{4 \sqrt{6}}$
$\Gamma_{1^+}^{\#4} \dagger \alpha$	0	0	$\frac{\sqrt{5} a_0}{6}$	$-\frac{\sqrt{5} a_0}{6}$	$-\frac{a_0}{6}$	$-\frac{1}{6} i \sqrt{\frac{5}{2}} a_0 k$
$\Gamma_{1^+}^{\#5} \dagger \alpha$	0	0	$-\frac{a_0}{6 \sqrt{2}}$	$\frac{a_0}{3}$	$\frac{a_0}{6 \sqrt{2}}$	$\frac{ia_0 k}{4 \sqrt{3}}$
$\Gamma_{1^+}^{\#6} \dagger \alpha$	0	0	$-\frac{a_0}{6}$	$\frac{a_0}{6 \sqrt{2}}$	$\frac{5a_0}{12}$	$\frac{ia_0 k}{4 \sqrt{6}}$
$\mathcal{H}_{1^+}^{\#1} \dagger \alpha$	0	$\frac{ia_0 k}{4 \sqrt{2}}$	0	$-\frac{ia_0 k}{4 \sqrt{3}}$	$-\frac{ia_0 k}{4 \sqrt{6}}$	0

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

$\Gamma_{2^+}^{\#1} \alpha \beta$	$\Gamma_{2^+}^{\#2} \alpha \beta$	$\Gamma_{2^+}^{\#3} \alpha \beta$	$\mathcal{H}_{2^+}^{\#1} \alpha \beta$	$\Gamma_{2^+}^{\#1} \alpha \beta \chi$	$\Gamma_{2^+}^{\#2} \alpha \beta \chi$
$\Gamma_{2^+}^{\#1} \dagger \alpha \beta$	$\frac{a_0}{4}$	0	$\frac{ia_0 k}{4 \sqrt{2}}$	0	0
$\Gamma_{2^+}^{\#2} \dagger \alpha \beta$	0	$-\frac{a_0}{2}$	$\frac{ia_0 k}{4 \sqrt{3}}$	0	0
$\Gamma_{2^+}^{\#3} \dagger \alpha \beta$	0	0	$-\frac{ia_0 k}{4 \sqrt{6}}$	0	0
$\mathcal{H}_{2^+}^{\#1} \dagger \alpha \beta$	$-\frac{ia_0 k}{4 \sqrt{2}}$	$\frac{ia_0 k}{4 \sqrt{3}}$	$-\frac{ia_0 k}{4 \sqrt{6}}$	0	0
$\Gamma_{2^+}^{\#1} \dagger \alpha \beta \chi$	0	0	$\frac{a_0}{4}$	$\frac{a_0}{4}$	0
$\Gamma_{2^+}^{\#2} \dagger \alpha \beta \chi$	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

$a_0 < 0$