Particle spectrograph

Wave operator and propagator

${\cal T}_{1^{\text{-}}}^{\#1}{}_{\alpha}$	0	0	0	$-\frac{2i\sqrt{2}k}{a_0(2+k^2)}$	$-\frac{ik(4+k^2)}{a_0(2+k^2)^2}$	$\frac{ik(6+5k^2)}{\sqrt{6}a_0(2+k^2)^2}$	$-\frac{i\sqrt{\frac{5}{6}}k}{a_0(2+k^2)}$	$\frac{2ik(3+k^2)}{\sqrt{3}a_0(2+k^2)^2}$	$-\frac{i}{a_0} \sqrt{\frac{2}{3}} k$	$\frac{2k^2}{a_0(2+k^2)^2}$
$\Delta_{1^{^{-}}\alpha}^{\#6}$	0	0	0	0	$-\frac{k^2}{\sqrt{6} a_0 (2+k^2)}$	$\frac{1}{-2 a_0 - \frac{8 a_0}{2+3 k^2}}$	$-\frac{\sqrt{5}}{6a_0}$	$-\frac{\sqrt{2} (7+3 k^2)}{3 a_0 (2+k^2)}$	340	$i \sqrt{\frac{2}{3}} k$ $2a_0 + a_0 k^2$
$\Delta_{1^{-}\alpha}^{\#5}$	0	0	0	$\sqrt{\frac{2}{3}} k^2$ $a_0 (2+k^2)$	$\frac{k^2 (5+2k^2)}{\sqrt{3} a_0 (2+k^2)^2}$	$\frac{-2+k^2}{3\sqrt{2} a_0 (2+k^2)^2}$	$-\frac{\sqrt{\frac{5}{2}}}{6a_0+3a_0k^2}$	$\frac{2(17+14k^2+3k^4)}{3a_0(2+k^2)^2}$	$-\frac{\sqrt{2} (7+3k^2)}{3 a_0 (2+k^2)}$	$-\frac{2ik(3+k^2)}{\sqrt{3}a_0(2+k^2)^2}$
$\Delta_{1^{-}}^{\#4}{}_{\alpha}$	0	0	0	0	$-\frac{\sqrt{\frac{5}{6}} k^2}{4 a_0 + 2 a_0 k^2}$	$\frac{\sqrt{5} (10+3 k^2)}{12 a_0 (2+k^2)}$	$\frac{1}{12a_0}$	$\sqrt{\frac{5}{2}}$ $6a_0 + 3a_0 k^2$	$\frac{\sqrt{5}}{6a_0}$	$i \sqrt{\frac{5}{6}} k$ $2a_0 + a_0 k^2$
$\Delta_{1^{-}\alpha}^{\#3}$	0	0	0	$-\frac{2k^2}{\sqrt{3}a_0(2+k^2)}$	$\frac{k^2 (-2+k^2)}{2 \sqrt{6} a_0 (2+k^2)^2}$	$-\frac{76+52k^2+3k^4}{12a_0(2+k^2)^2}$	$\frac{\sqrt{5} (10+3k^2)}{12 a_0 (2+k^2)}$	$\frac{-2+k^2}{3\sqrt{2}\ a_0\ (2+k^2)^2}$	$\frac{1}{-2 a_0 - \frac{8 a_0}{2 + 3 k^2}}$	$-\frac{ik(6+5k^2)}{\sqrt{6}a_0(2+k^2)^2}$
$\Delta_{1^{-}\alpha}^{\#2}$	0	0	0	$\frac{\sqrt{2} (4+k^2)}{a_0 (2+k^2)}$	$\frac{(4+k^2)^2}{2 a_0 (2+k^2)^2}$	$\frac{k^2 (-2+k^2)}{2 \sqrt{6} a_0 (2+k^2)^2}$	$\sqrt{\frac{5}{6}} k^2 - \frac{4a_0 + 2a_0 k^2}{4}$	$\frac{k^2 (5+2 k^2)}{\sqrt{3} a_0 (2+k^2)^2}$	$-\frac{k^2}{\sqrt{6}(2a_0+a_0k^2)}$	$\frac{i k (4+k^2)}{a_0 (2+k^2)^2}$
$\Delta_{1}^{\#1}{}_{\alpha}$	0	0	0	0	$\frac{\sqrt{2} (4+k^2)}{a_0 (2+k^2)}$	$-\frac{2k^2}{\sqrt{3}(2a_0+a_0k^2)}$	0	$\sqrt{\frac{2}{3}} k^2$ $2a_0 + a_0 k^2$	0	$\frac{2i\sqrt{2}k}{2a_0 + a_0k^2}$
$\Delta_{1}^{\#3}_{\alpha\beta}$	0	0	$\frac{4}{a_0}$	0	0	0	0	0	0	0
$\Delta_{1}^{\#1}_{\alpha\beta} \; \Delta_{1}^{\#2}_{\alpha\beta} \; \Delta_{1}^{\#3}_{\alpha\beta}$	$-\frac{2\sqrt{2}}{a_0}$	$\frac{2}{a_0}$	0	0	0	0	0	0	0	0
$\Delta_{1}^{\#1}{}_{\alpha\beta}$	0	$\frac{2\sqrt{2}}{a_0}$	0	0	0	0	0	0	0	0
	$\Delta_{1}^{\#1} + \alpha^{\beta}$	$\Delta_{1}^{\#2} \dagger^{\alpha\beta}$	$\Delta_1^{\#3} + ^{\alpha\beta}$	$\Delta_1^{\#1} +^{lpha}$	$\Delta_1^{\#2} +^{\alpha}$	$\Delta_1^{\#3} +^{\alpha}$	$\Delta_1^{\#4} + ^{\alpha}$	$\Delta_1^{\#5} +^{\alpha}$	$\Delta_1^{\#6} +^{\alpha}$	${\cal T}_{1}^{\#1}\dagger^{lpha}$

Quadratic (free) Lagrangian density
$\frac{1}{-\frac{1}{2}} a_0 \Gamma^{\alpha\beta\chi} \Gamma_{\beta\chi\alpha} + \frac{1}{2} a_0 \Gamma^{\alpha\beta}_{\alpha} \Gamma^{\chi}_{\beta\chi} + h^{\alpha\beta} \mathcal{T}_{\alpha\beta} + \Gamma^{\alpha\beta\chi} \Delta_{\alpha\beta\chi}$
$\frac{1}{4} a_0 h_{\chi}^{\chi} \partial_{\beta} \Gamma^{\alpha}{}_{\alpha}{}^{\beta} + \frac{1}{4} a_0 h_{\chi}^{\chi} \partial_{\beta} \Gamma^{\alpha\beta}{}_{\alpha} - \frac{1}{2} a_0 h_{\alpha\chi} \partial_{\beta} \Gamma^{\alpha\beta\chi} + \frac{1}{2} a_0 h_{\beta\chi} \partial^{\chi} \Gamma^{\alpha}{}_{\alpha}{}^{\beta}$

$\Delta_{0}^{\#1}$	0	0	0	0	0	0	$-\frac{2}{a_0}$
$\tau_0^{#2}$	$-\frac{2i\sqrt{6}k}{16a_0+3a_0k^2}$	$\frac{72ik}{a_0(16+3k^2)^2}$	$-\frac{8ik(19+3k^2)}{a_0(16+3k^2)^2}$	$\frac{4i\sqrt{2}k(10+3k^2)}{a_0(16+3k^2)^2}$	$\frac{4\sqrt{3}}{16a_0 + 3a_0 k^2}$	$-\frac{36k^2}{a_0(16+3k^2)^2}$	0
${\mathcal T}^{\#1}_{0}$	2 i √2 a0 k	$-\frac{8i\sqrt{3}}{16a_0k+3a_0k^3}$	$\frac{8i}{\sqrt{3}(16a_0k + 3a_0k^3)}$	$8i \sqrt{\frac{2}{3}}$ $16a_0 k + 3a_0 k^{3}$	$\frac{4}{a_0 k^2}$	$\frac{4\sqrt{3}}{16a_0 + 3a_0 k^2}$	0
$\Delta_{0}^{\#4}$	$\frac{8}{\sqrt{3}(16a_0+3a_0k^2)}$	$-\frac{8\sqrt{2}(10+3k^2)}{a_0(16+3k^2)^2}$	$-\frac{8\sqrt{2}(22+3k^2)}{3a_0(16+3k^2)^2}$	$\frac{32(13+3k^2)}{3a_0(16+3k^2)^2}$	$-\frac{8i\sqrt{\frac{2}{3}}}{16a_0k+3a_0k^3}$	$-\frac{4i\sqrt{2}k(10+3k^2)}{a_0(16+3k^2)^2}$	0
$\Delta_{0}^{\#3}$	$4 \sqrt{\frac{2}{3}}$ $- \frac{16 a_0 + 3 a_0 k^2}{2}$	$\frac{16(19+3k^2)}{a_0(16+3k^2)^2}$	$-\frac{16(35+6k^2)}{3a_0(16+3k^2)^2}$	$-\frac{8\sqrt{2}(22+3k^2)}{3a_0(16+3k^2)^2}$	$\frac{8i}{\sqrt{3}(16a_0k+3a_0k^3)}$	$\frac{8ik(19+3k^2)}{a_0(16+3k^2)^2}$	0
$\Delta_0^{\#2}$	$4\sqrt{6}$ $16a_0+3a_0k^2$	$-\frac{144}{a_0(16+3k^2)^2}$	$\frac{16(19+3k^2)}{a_0(16+3k^2)^2}$	$-\frac{8\sqrt{2}(10+3k^2)}{a_0(16+3k^2)^2}$	$8i \sqrt{3} \\ 16a_0 k + 3a_0 k^3$	$-\frac{72ik}{a_0(16+3k^2)^2}$	0
$\Delta_{0}^{\#1}$	0	$\frac{4\sqrt{6}}{16a_0 + 3a_0 k^2}$	$-\frac{4\sqrt{\frac{2}{3}}}{16a_0+3a_0k^2}$	$-\frac{8}{\sqrt{3}(16a_0+3a_0k^2)}$	$\frac{2i\sqrt{2}}{a_0k}$	$\frac{2i\sqrt{6}k}{16a_0+3a_0k^2}$	0
	$\Delta_{0}^{\#1}$ †	$\Delta_{0}^{#2} +$	$\Delta_{0}^{#3}$ †	$\Delta_{0}^{\#4}$ †	$\mathcal{T}_{0}^{\#1}$ †	$\mathcal{T}_{0}^{\#2} +$	$\Delta_{0}^{\#1}\dagger$

Source constraints/gauge generators	
SO(3) irreps	Multiplicities
$2\mathcal{T}_{0^{+}}^{\#2} - \bar{\imath}k\Delta_{0^{+}}^{\#2} == 0$	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

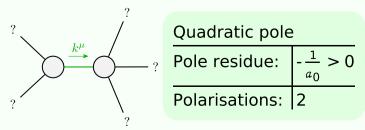
$h_{1}^{\#1}$	0	0	0	$-\frac{i a_0 k}{4 \sqrt{2}}$	0	$\frac{i a_0 k}{4 \sqrt{6}}$	$\sqrt{\frac{5}{6}} a_0 k$	$\frac{ia_0 k}{4 \sqrt{3}}$	$\frac{i a_0 k}{4 \sqrt{6}}$	0
				i		7			<u>i</u>	Milia
$\Gamma_{1^{-}}^{\#6}{}_{\alpha}$	0	0	0	0	0	$\frac{a0}{6}$	$\left -\frac{\sqrt{5} a_0}{6} \right $	$\frac{a_0}{6\sqrt{2}}$	5 <i>a</i> 0	$-\frac{ia_0k}{4\sqrt{6}}$
$\Gamma_{1^{-}\alpha}^{\#5}$	0	0	0	0	0	$-\frac{a_0}{6\sqrt{2}}$	$-\frac{1}{6}\sqrt{\frac{5}{2}}a_0$	8 0	$\frac{a_0}{6\sqrt{2}}$	$-\frac{ia_0k}{4\sqrt{3}}$
$\Gamma_{1}^{\#4}$	0	0	0	0	0	$\sqrt{5} a_0$	8 3	$-\frac{1}{6}\sqrt{\frac{5}{2}}a_0$	$-\frac{\sqrt{5} a_0}{6}$	$\frac{1}{4}\overline{i}\sqrt{\frac{5}{6}}a_0k$
$\Gamma_{1^{-}\alpha}^{\#3}$	0	0	0	0	0	$\frac{\varepsilon}{0p}$	$\sqrt{5} a_0$	$-\frac{a_0}{6\sqrt{2}}$	$\frac{9}{0v}$	$-\frac{ia_0k}{4\sqrt{6}}$
$\Gamma_{1}^{\#2}$	0	0	0	$\frac{a_0}{2\sqrt{2}}$	0	0	0	0	0	0
$\Gamma_{1^{-}}^{\#1}{}_{\alpha}$	0	0	0	$-\frac{a_0}{4}$	$\frac{a_0}{2\sqrt{2}}$	0	0	0	0	$\frac{i a_0 k}{4 \sqrt{2}}$
$\Gamma_{1}^{\#3}$	0	0	$\frac{a_0}{4}$	0	0	0	0	0	0	0
$\Gamma_{1}^{\#1}$ $\Gamma_{1}^{\#2}$ $\alpha \beta$	$-\frac{a_0}{2\sqrt{2}}$	0	0	0	0	0	0	0	0	0
$\Gamma_{1}^{\#1}$	$-\frac{a_0}{4}$	$-\frac{a_0}{2\sqrt{2}}$	0	0	0	0	0	0	0	0
	$\Gamma_1^{\#1} + \alpha \beta$	$\Gamma_1^{\#2} + \alpha \beta$	$\Gamma_1^{\#3} + ^{\alpha\beta}$	$\Gamma_{1}^{\#1} +^{\alpha}$	$\Gamma_{1}^{\#2} \uparrow^{\alpha}$	$\Gamma_{1}^{#3} + \alpha$	$\Gamma_{1}^{\#4} +^{\alpha}$	$\Gamma_{1}^{\#5} +^{\alpha}$	$\Gamma_{1}^{\#6}$ \pm^{lpha}	$h_1^{\#1} +^{\alpha}$

$\Gamma_{0^{\text{-}}}^{\#1}$	0	0	0	0	0	0	$-\frac{a_0}{2}$
$h_{0}^{#2}$	0	0	$-\frac{1}{4}\bar{I}a_0k$	$\frac{i a_0 k}{4 \sqrt{2}}$	0	0	0
$h_0^{\#1}$	$-\frac{ia_0k}{2\sqrt{2}}$	0	$\frac{i a_0 k}{4 \sqrt{3}}$	$-\frac{ia_0k}{4\sqrt{6}}$	0	0	0
Γ#4 0+	0	$-\frac{a_0}{2\sqrt{2}}$	$-\frac{a_0}{2\sqrt{2}}$	$\frac{a_0}{2}$	$\frac{i a_0 k}{4 \sqrt{6}}$	$-\frac{ia_0k}{4\sqrt{2}}$	0
Γ _{#3}	0	$\frac{a_0}{2}$	0	$-\frac{a_0}{2\sqrt{2}}$	$-\frac{ia_0k}{4\sqrt{3}}$	$\frac{i a_0 k}{4}$	0
Γ#2 0+	0	0	$\frac{a_0}{2}$	$-\frac{a_0}{2\sqrt{2}}$	0	0	0
$\Gamma_0^{\#1}$	$-\frac{a_0}{2}$	0	0	0	$\frac{i a_0 k}{2 \sqrt{2}}$	0	0
	$\Gamma_{0}^{#1}$ †	Γ#2 +	Γ ₀ ^{#3} †	Γ#4 0+ †	$h_0^{#1}$ †	$h_0^{#2} +$	$\Gamma_{0}^{\#1}$ \dagger

$\Lambda_{2}^{#2}$ $\alpha \beta \chi$	0	0	0	0	0	$\frac{4}{a_0}$
$\Delta_{2^{-}}^{\#1}\alpha\beta\chi~\Delta_{2^{-}}^{\#2}$	0	0	0	0	4 a ₀	0
${\mathcal T}_{2}^{\#1}_{\alpha\beta}$	4 i √2 a 0 k	$\frac{4i}{\sqrt{3}a_0k}$	$-\frac{4i\sqrt{\frac{2}{3}}}{a_0k}$	$-\frac{8}{a_0 k^2}$	0	0
$\Delta_{2}^{\#3}{}_{\alpha\beta}$	$\frac{4}{\sqrt{3}a_0}$	$-\frac{2\sqrt{2}}{3a_0}$	340	$\frac{4i\sqrt{\frac{2}{3}}}{a_0k}$	0	0
$\Delta_{2}^{\#2}{}_{\alpha\beta}$	$2\sqrt{\frac{2}{3}}$ a_0	$-\frac{8}{3a_0}$	$\frac{2\sqrt{2}}{3a_0}$	$\frac{4i}{\sqrt{3}a_0k}$	0	0
$\Delta_{2}^{\#1}{}_{\alpha\beta}$	0	$2\sqrt{\frac{2}{3}}$ a_0	4 √3 a ₀	4 i √2 a0 k	0	0
,	$\Delta_{2}^{\#1} + \alpha \beta$	$\Delta_{2}^{#2} + \alpha \beta$	$\Delta_{2}^{#3} + \alpha \beta$	$^{-#1}_{2}$	$\Delta_{2^{-}}^{#1} +^{\alpha\beta\chi}$	$\Delta_{2}^{#2} + \alpha \beta \chi$

$\Gamma_{2^{-}}^{\#2} \alpha \beta \chi$	0	0	0	0	0	$\frac{a_0}{4}$
$\Gamma_{2}^{\#3} \mu_{2}^{\#1} \mu_{2}^{\#1} \Gamma_{2}^{\#1} \alpha_{\beta\chi} \Gamma_{2}^{\#2}$	0	0	0	0	<u>4</u>	0
$h_2^{\#1}_{+}\alpha\beta$	$\frac{i a_0 k}{4 \sqrt{2}}$	$\frac{i a_0 k}{4 \sqrt{3}}$	$-\frac{ia_0k}{4\sqrt{6}}$	0	0	0
$\Gamma_{2}^{\#3}{}_{\alpha\beta}$	0	0	$\frac{a_0}{4}$	$\frac{i a_0 k}{4 \sqrt{6}}$	0	0
$\Gamma_{2}^{\#1}$ $\alpha_{2}^{\#2}$	0	$-\frac{a_0}{2}$	0	$-\frac{ia_0k}{4\sqrt{3}}$	0	0
$\Gamma_{2}^{\#1}{}_{\alpha\beta}$	<u>4</u>	0	0	$-\frac{ia_0k}{4\sqrt{2}}$	0	0
	$\Gamma_2^{#1} + \alpha \beta$	$\Gamma_{2}^{#2} + \alpha^{\beta}$	$\Gamma_{2}^{#3} + \alpha \beta$	$h_2^{#1} + \alpha \beta$	$\Gamma_{2}^{#1} +^{\alpha\beta\chi}$	$\Gamma_2^{\#2} + \alpha \beta \chi$

Massive and massless spectra



(No massive particles)

Unitarity conditions