



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

(No massive particles)

Unitarity conditions

$a_0 < 0$

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

| $\Gamma_{1^+}^{\#1} \uparrow \alpha \beta$ | $\Gamma_{1^+}^{\#2} \uparrow \alpha \beta$ | $\Gamma_{1^+}^{\#3} \uparrow \alpha \beta$ | $\Gamma_{1^+}^{\#1} \uparrow \alpha$ | $\Gamma_{1^+}^{\#2} \uparrow \alpha$ | $\Gamma_{1^+}^{\#3} \uparrow \alpha$ | $\Gamma_{1^+}^{\#4} \uparrow \alpha$ | $\Gamma_{1^+}^{\#5} \uparrow \alpha$ | $\Gamma_{1^+}^{\#6} \uparrow \alpha$ | $h_{1^+}^{\#1} \uparrow \alpha$ |
|--|--|--|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|---------------------------------|
| $\Gamma_{1^+}^{\#1} \uparrow \alpha \beta$ | $-\frac{a_0}{4}$                           | $-\frac{a_0}{2\sqrt{2}}$                   | 0                                    | 0                                    | 0                                    | 0                                    | 0                                    | 0                                    | 0                               |
| $\Gamma_{1^+}^{\#2} \uparrow \alpha \beta$ | $-\frac{a_0}{2\sqrt{2}}$                   | 0  | 0                                    | 0                                    | 0                                    | 0                                    | 0                                    | 0                                    | 0                               |
| $\Gamma_{1^+}^{\#3} \uparrow \alpha \beta$ | 0  | 0  | $\frac{a_0}{4}$                      | 0                                    | 0                                    | 0                                    | 0                                    | 0                                    | 0                               |
| $\Gamma_{1^+}^{\#1} \uparrow \alpha$       | 0  | 0  | 0                                    | $-\frac{a_0}{2\sqrt{2}}$             | 0                                    | 0                                    | 0                                    | 0                                    | 0                               |
| $\Gamma_{1^+}^{\#2} \uparrow \alpha$       | 0  | 0  | $\frac{a_0}{2\sqrt{2}}$              | 0                                    | 0                                    | 0                                    | 0                                    | 0                                    | 0                               |
| $\Gamma_{1^+}^{\#3} \uparrow \alpha$       | 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                               |
| $\Gamma_{1^+}^{\#4} \uparrow \alpha$       | 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                               |
| $\Gamma_{1^+}^{\#5} \uparrow \alpha$       | 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                               |
| $\Gamma_{1^+}^{\#6} \uparrow \alpha$       | 0  | 0  | 0                                    | 0                                    | $-\frac{a_0}{6}$                     | $-\frac{\sqrt{5}a_0}{6}$             | $\frac{a_0}{6\sqrt{2}}$              | $\frac{5a_0}{12}$                    | 0                               |
| $h_{1^+}^{\#1} \uparrow \alpha$            | 0  | 0  | 0                                    | 0                                    | 0                                    | 0                                    | 0                                    | 0                                    | 0                               |

Lagrangian density

$$\begin{aligned}
&-\frac{1}{2}a_0\,\Gamma^{\alpha\beta\chi}\,\Gamma_{\beta\chi\alpha}+\frac{1}{2}a_0\,\Gamma^\alpha_\alpha\,\Gamma^\beta_\beta\,\Gamma^\chi_\chi+h^{\alpha\beta}\,\mathcal{T}_{\alpha\beta}+\Gamma^{\alpha\beta\chi}\,\Delta_{\alpha\beta\chi}-\\
&\frac{1}{2}a_0\,\Gamma^{\alpha\beta\chi}\,\partial_\beta h_{\alpha\chi}-\frac{1}{4}a_0\,\Gamma^\alpha_\alpha\,\Gamma^\beta_\beta\,\partial_\beta h^\chi_\chi+\frac{1}{4}a_0\,\Gamma^{\alpha\beta}_\alpha\,\Gamma^{\beta\chi}_\alpha\,\partial_\beta h^\chi_\chi-\frac{1}{4}a_0\,h^\chi_\chi\,\partial_\beta\Gamma^\alpha_\alpha\,\beta+\\
&\frac{1}{4}a_0\,h^\chi_\chi\,\partial_\beta\Gamma^{\alpha\beta}_\alpha-\frac{1}{2}a_0\,h_{\alpha\chi}\,\partial_\beta\Gamma^{\alpha\beta\chi}+\frac{1}{2}a_0\,h^{\alpha\beta}\,\partial_\beta\partial_\alpha h^\chi_\chi-\frac{1}{2}a_0\,\partial_\beta h^\chi_\chi\,\partial^\beta h^\alpha_\alpha+\\
&\frac{1}{2}a_0\,\Gamma^\alpha_\alpha\,\beta\,\partial_\chi h^\chi_\beta-\frac{1}{2}a_0\,\partial_\alpha h^{\alpha\beta}\,\partial_\chi h^\chi_\beta+\frac{1}{2}a_0\,\partial^\beta h^\alpha_\alpha\,\partial_\chi h^\chi_\beta-\frac{1}{2}a_0\,h^{\alpha\beta}\,\partial_\chi\partial_\beta h^\chi_\chi+\\
&\frac{1}{4}a_0\,h^\alpha_\alpha\,\partial_\chi\partial_\beta h^{\beta\chi}+\frac{1}{2}a_0\,h^{\alpha\beta}\,\partial_\chi\partial^\chi h_{\alpha\beta}-\frac{1}{4}a_0\,h^\alpha_\alpha\,\partial_\chi\partial^\chi h^\beta_\beta-\\
&\frac{1}{4}a_0\,\partial_\beta h_{\alpha\chi}\,\partial^\chi h^{\alpha\beta}+\frac{3}{8}a_0\,\partial_\chi h_{\alpha\beta}\,\partial^\chi h^{\alpha\beta}+\frac{1}{2}a_0\,h_{\beta\chi}\,\partial^\chi\Gamma^\alpha_\alpha\,\beta
\end{aligned}$$

| $\Delta_{0^+}^{\#1} \uparrow$      | $\Delta_{0^+}^{\#2} \uparrow$ | $\Delta_{0^+}^{\#3} \uparrow$ | $\Delta_{0^+}^{\#4} \uparrow$ | $\mathcal{T}_{0^+}^{\#1} \uparrow$ | $\mathcal{T}_{0^+}^{\#2} \uparrow$ | $\Delta_{0^+}^{\#1} \uparrow$ |
|------------------------------------|-------------------------------|-------------------------------|-------------------------------|------------------------------------|------------------------------------|-------------------------------|
| $\Delta_{0^+}^{\#1} \uparrow$      | $-\frac{2}{a_0}$              | 0                             | 0                             | 0                                  | 0                                  | 0                             |
| $\Delta_{0^+}^{\#2} \uparrow$      | 0                             | $-\frac{3}{4a_0}$             | $-\frac{5}{4a_0}$             | $-\frac{1}{2\sqrt{2}a_0}$          | 0                                  | 0                             |
| $\Delta_{0^+}^{\#3} \uparrow$      | 0                             | $\frac{5}{4a_0}$              | $-\frac{3}{4a_0}$             | $-\frac{1}{2\sqrt{2}a_0}$          | 0                                  | 0                             |
| $\Delta_{0^+}^{\#4} \uparrow$      | 0                             | $-\frac{1}{2\sqrt{2}a_0}$     | $-\frac{1}{2\sqrt{2}a_0}$     | $\frac{1}{2a_0}$                   | 0                                  | 0                             |
| $\mathcal{T}_{0^+}^{\#1} \uparrow$ | 0                             | 0                             | 0                             | $\frac{4}{a_0k^2}$                 | 0                                  | 0                             |
| $\mathcal{T}_{0^+}^{\#2} \uparrow$ | 0                             | 0                             | 0                             | 0                                  | 0                                  | 0                             |
| $\Delta_{0^+}^{\#1} \uparrow$      | 0                             | 0                             | 0                             | 0                                  | 0                                  | $-\frac{2}{a_0}$              |

$$\Delta_{3^+}^{\#1} \uparrow \alpha \beta \chi \quad \boxed{-\frac{2}{a_0}}$$

$$\Gamma_{3^+}^{\#1} \uparrow \alpha \beta \chi \quad \boxed{-\frac{a_0}{2}}$$

| $\Delta_{2^+}^{\#1} \uparrow \alpha \beta$      | $\Delta_{2^+}^{\#2} \uparrow \alpha \beta$ | $\Delta_{2^+}^{\#3} \uparrow \alpha \beta$ | $\mathcal{T}_{2^+}^{\#1} \uparrow \alpha \beta$ | $\Delta_{2^+}^{\#1} \uparrow \alpha \beta \chi$ | $\Delta_{2^+}^{\#2} \uparrow \alpha \beta \chi$ |
|---|--|--|---|---|---|
| $\Delta_{2^+}^{\#1} \uparrow \alpha \beta$      | $\frac{4}{a_0}$                            | 0  | 0   | 0   | 0   |
| $\Delta_{2^+}^{\#2} \uparrow \alpha \beta$      | 0  | $-\frac{2}{a_0}$                           | 0   | 0   | 0   |
| $\Delta_{2^+}^{\#3} \uparrow \alpha \beta$      | 0  | 0  | $\frac{4}{a_0}$                                 | 0   | 0   |
| $\mathcal{T}_{2^+}^{\#1} \uparrow \alpha \beta$ | 0  | 0  | $-\frac{8}{a_0k^2}$                             | 0   | 0   |
| $\Delta_{2^+}^{\#1} \uparrow \alpha \beta \chi$ | 0  | 0  | 0   | $\frac{4}{a_0}$                                 | 0   |
| $\Delta_{2^+}^{\#2} \uparrow \alpha \beta \chi$ | 0  | 0  | 0   | 0   | $\frac{4}{a_0}$                                 |

| $\Gamma_{2^+}^{\#1} \uparrow \alpha \beta$      | $\Gamma_{2^+}^{\#2} \uparrow \alpha \beta$ | $\Gamma_{2^+}^{\#3} \uparrow \alpha \beta$ | $h_{2^+}^{\#1} \uparrow \alpha \beta$ | $\Gamma_{2^+}^{\#1} \uparrow \alpha \beta \chi$ | $\Gamma_{2^+}^{\#2} \uparrow \alpha \beta \chi$ |
|---|--|--|---------------------------------------|---|---|
| $\Gamma_{2^+}^{\#1} \uparrow \alpha \beta$      | $\frac{a_0}{4}$                            | 0  | 0                                     | 0   | 0   |
| $\Gamma_{2^+}^{\#2} \uparrow \alpha \beta$      | 0  | $-\frac{a_0}{2}$                           | 0                                     | 0   | 0   |
| $\Gamma_{2^+}^{\#3} \uparrow \alpha \beta$      | 0  | 0  | $\frac{a_0}{4}$                       | 0   | 0   |
| $h_{2^+}^{\#1} \uparrow \alpha \beta$           | 0  | 0  | $-\frac{a_0k^2}{8}$                   | 0   | 0   |
| $\Gamma_{2^+}^{\#1} \uparrow \alpha \beta \chi$ | 0  | 0  | 0                                     | $\frac{a_0}{4}$                                 | 0   |
| $\Gamma_{2^+}^{\#2} \uparrow \alpha \beta \chi$ | 0  | 0  | 0                                     | 0   | $\frac{a_0}{4}$                                 |

| $\Gamma_{0^+}^{\#1} \uparrow$ | $\Gamma_{0^+}^{\#2} \uparrow$ | $\Gamma_{0^+}^{\#3} \uparrow$ | $\Gamma_{0^+}^{\#4} \uparrow$ | $h_{0^+}^{\#1} \uparrow$ | $h_{0^+}^{\#2} \uparrow$ | $\Gamma_{0^+}^{\#1} \uparrow$ |
|-------------------------------|-------------------------------|-------------------------------|-------------------------------|--------------------------|--------------------------|-------------------------------|
| $\Gamma_{0^+}^{\#1} \uparrow$ | $-\frac{a_0}{2}$              | 0                             | 0                             | 0                        | 0                        | 0                             |
| $\Gamma_{0^+}^{\#2} \uparrow$ | 0                             | 0                             | $\frac{a_0}{2}$               | $-\frac{a_0}{2\sqrt{2}}$ | 0                        | 0                             |
| $\Gamma_{0^+}^{\#3} \uparrow$ | 0                             | $\frac{a_0}{2}$               | 0                             | $-\frac{a_0}{2\sqrt{2}}$ | 0                        | 0                             |
| $\Gamma_{0^+}^{\#4} \uparrow$ | 0                             | $-\frac{a_0}{2\sqrt{2}}$      | $-\frac{a_0}{2\sqrt{2}}$      | $\frac{a_0}{2}$          | 0                        | 0                             |
| $h_{0^+}^{\#1} \uparrow$      | 0                             | 0                             | 0                             | $\frac{a_0k^2}{4}$       | 0                        | 0                             |
| $h_{0^+}^{\#2} \uparrow$      | 0                             | 0                             | 0                             | 0                        | 0                        | 0                             |
| $\Gamma_{0^+}^{\#1} \uparrow$ | 0                             | 0                             | 0                             | 0                        | 0                        | $-\frac{a_0}{2}$              |