

Wave operator

$$S = \iiint \left(\frac{1}{4} \left(2 a_0 \cdot \mathcal{T}^{\alpha \beta}{}_{\alpha}{}^{\beta} \mathcal{T}^{\chi}{}_{\beta \chi} + \mathcal{T}^{\alpha \beta \chi} \left(-2 a_0 \cdot \mathcal{T}_{\beta \chi \alpha} + 4 \mathcal{W}_{\alpha \beta \chi} \right) + 4 \mathcal{T}^{\alpha \beta}{}_{\alpha}{}^{\beta} h_{\alpha \beta} - a_0 \cdot h^{\chi}{}_{\chi} \partial_{\beta} \mathcal{T}^{\alpha \beta}{}_{\alpha}{}^{\beta} + a_0 \cdot h^{\chi}{}_{\chi} \partial_{\beta} \mathcal{T}^{\alpha \beta}{}_{\alpha}{}^{\beta} - 2 a_0 \cdot h_{\alpha \chi} \partial_{\beta} \mathcal{T}^{\alpha \beta \chi} + 2 a_0 \cdot h_{\beta \chi} \partial^{\chi} \mathcal{T}^{\alpha}{}_{\alpha}{}^{\beta} - c_2 \partial_{\beta} \mathcal{T}^{\delta}{}_{\delta \chi} \partial^{\chi} \mathcal{T}^{\alpha}{}_{\alpha}{}^{\beta} - c_2 \partial_{\chi} \mathcal{T}^{\delta}{}_{\delta \beta} \partial^{\beta} \mathcal{T}^{\alpha}{}_{\alpha}{}^{\beta} - c_2 \partial_{\beta} \mathcal{T}^{\alpha \beta \chi} \partial_{\delta} \mathcal{T}^{\delta}{}_{\alpha}{}^{\chi} - 2 c_2 \partial^{\chi} \mathcal{T}^{\alpha}{}_{\alpha}{}^{\beta} \partial_{\delta} \mathcal{T}_{\beta}{}^{\delta}{}_{\chi} + c_2 \partial_{\beta} \mathcal{T}^{\alpha \beta \chi} \partial_{\delta} \mathcal{T}_{\chi}{}^{\delta}{}_{\alpha} + 2 c_2 \partial^{\chi} \mathcal{T}^{\alpha}{}_{\alpha}{}^{\beta} \partial_{\delta} \mathcal{T}_{\chi}{}^{\delta}{}_{\beta} \right) \right) \mathcal{E}, \quad \chi, \, y, \, z \int d z \, d y \, d x \, d t$$

Saturated propagator

$\mathcal{Q}^{\dagger} h^{\dagger}$	$\mathcal{Q}^{\dagger} h^{\parallel}$	$\mathcal{Q}^{\dagger} \mathcal{T}_0^{\parallel}$	$\mathcal{Q}^{\dagger} \mathcal{T}_5^{\perp \dagger}$	$\mathcal{Q}^{\dagger} \mathcal{T}_5^{\parallel}$	$\mathcal{Q}^{\dagger} \mathcal{T}_5^{\perp h}$	$\mathcal{Q}^{\dagger} \mathcal{T}_5^{\parallel}$
$\mathcal{Q}^{\dagger} h^{\dagger} \dagger$	0	0	0	0	$\frac{I a_2 k}{4} - \frac{I a_2 k}{4 \sqrt{2}}$	0
$\mathcal{Q}^{\dagger} h^{\parallel} \dagger$	0	0	$\frac{I a_2 k}{2 \sqrt{2}}$	0	$-\frac{I a_2 k}{4 \sqrt{3}}$	$\frac{I a_2 k}{4 \sqrt{6}}$
$\mathcal{Q}^{\dagger} \mathcal{T}_0^{\parallel} \dagger$	0	$-\frac{I a_2 k}{2 \sqrt{2}}$	$-\frac{a_2}{2}$	0	0	0
$\mathcal{Q}^{\dagger} \mathcal{T}_5^{\perp \dagger} \dagger$	0	0	0	0	$\frac{a_2}{2}$	$-\frac{a_2}{2 \sqrt{2}}$
$\mathcal{Q}^{\dagger} \mathcal{T}_5^{\parallel} \dagger$	$-\frac{1}{4} I a_2 k$	$\frac{I a_2 k}{4 \sqrt{3}}$	0	$\frac{a_2}{2}$	0	$-\frac{a_2}{2 \sqrt{2}}$
$\mathcal{Q}^{\dagger} \mathcal{T}_5^{\perp h} \dagger$	$\frac{I a_2 k}{4 \sqrt{2}}$	$-\frac{I a_2 k}{4 \sqrt{6}}$	0	$-\frac{a_2}{2 \sqrt{2}}$	$-\frac{a_2}{2 \sqrt{2}}$	$\frac{a_2}{2}$
$\mathcal{Q}^{\dagger} \mathcal{T}_5^{\parallel} \dagger$	0	0	0	0	0	$-\frac{a_2}{2}$
$\mathcal{P}^{\dagger} \mathcal{T}_0^{\parallel} \dagger^{\alpha \beta}$	$\frac{1}{4} \left(-a_0 - c_2 k^2 \right)$	$-\frac{a_2}{2 \sqrt{2}}$	$-\frac{c_2 k^2}{4}$			
$\mathcal{P}^{\dagger} \mathcal{T}_0^{\perp} \dagger^{\alpha \beta}$	$-\frac{a_2}{2 \sqrt{2}}$	0	0			
$\mathcal{P}^{\dagger} \mathcal{T}_5^{\perp} \dagger^{\alpha \beta}$	$-\frac{c_2 k^2}{4}$	0	$\frac{1}{4} \left(a_0 - c_2 k^2 \right)$			
$\mathcal{P}^{\dagger} h^{\dagger} \dagger^{\alpha}$	0	0	0			
$\mathcal{P}^{\dagger} \mathcal{T}_0^{\parallel} \dagger^{\alpha}$	0	0	0			
$\mathcal{P}^{\dagger} \mathcal{T}_0^{\perp} \dagger^{\alpha}$	0	0	0			
$\mathcal{P}^{\dagger} \mathcal{T}_5^{\perp \dagger} \dagger^{\alpha}$	0	0	0			
$\mathcal{P}^{\dagger} \mathcal{T}_5^{\parallel \dagger} \dagger^{\alpha}$	0	0	0			
$\mathcal{P}^{\dagger} \mathcal{T}_5^{\perp h} \dagger^{\alpha}$	0	0	0			
$\mathcal{P}^{\dagger} \mathcal{T}_5^{\parallel h} \dagger^{\alpha}$	0	0	0			
$\mathcal{P}^{\dagger} \mathcal{T}_5^{\parallel h} \dagger^{\alpha \beta \chi}$	$\frac{1}{12} \left(-2 a_0 + c_2 k^2 \right)$	$\frac{1}{12} \sqrt{5} \left(-2 a_0 + c_2 k^2 \right)$	$\frac{a_2 + c_2 k^2}{6 \sqrt{2}}$	$\frac{1}{12} \left(5 a_0 - c_2 k^2 \right)$		
$\mathcal{P}^{\dagger} h^{\parallel} \dagger^{\alpha \beta}$	0	$-\frac{I a_2 k}{4 \sqrt{2}}$	$-\frac{I a_2 k}{4 \sqrt{3}}$	$\frac{I a_2 k}{4 \sqrt{6}}$	0	0
$\mathcal{P}^{\dagger} \mathcal{T}_0^{\parallel} \dagger^{\alpha \beta}$	$\frac{I a_2 k}{4 \sqrt{2}}$	$\frac{a_2}{4}$	0	0	0	0
$\mathcal{P}^{\dagger} \mathcal{T}_5^{\perp} \dagger^{\alpha \beta}$	$\frac{I a_2 k}{4 \sqrt{3}}$	0	$-\frac{a_2}{2}$	0	0	0
$\mathcal{P}^{\dagger} \mathcal{T}_5^{\perp} \dagger^{\alpha \beta}$	$-\frac{I a_2 k}{4 \sqrt{6}}$	0	0	$\frac{a_2}{4}$	0	0
$\mathcal{P}^{\dagger} \mathcal{T}_0^{\perp} \dagger^{\alpha \beta \chi}$	0	0	0	0	$\frac{a_2}{4}$	0
$\mathcal{P}^{\dagger} \mathcal{T}_5^{\perp} \dagger^{\alpha \beta \chi}$	0	0	0	0	0	$\frac{a_2}{4}$
$\mathcal{P}^{\dagger} \mathcal{T}_5^{\parallel} \dagger^{\alpha \beta \chi}$	$-\frac{a_2}{2}$	0	0	0	0	0

Spin-parity form

$\mathcal{Q}^{\dagger} \mathcal{T}^{\perp}$	$\mathcal{Q}^{\dagger} \mathcal{T}^{\parallel}$	$\mathcal{Q}^{\dagger} \mathcal{W}_0^{\parallel}$	$\mathcal{Q}^{\dagger} \mathcal{W}_5^{\perp \dagger}$	$\mathcal{Q}^{\dagger} \mathcal{W}_5^{\parallel}$	$\mathcal{Q}^{\dagger} \mathcal{W}_5^{\perp h}$	$\mathcal{Q}^{\dagger} \mathcal{W}_0^{\parallel}$	
$\mathcal{Q}^{\dagger} \mathcal{T}^{\perp} \dagger$	$-\frac{36 k^2}{a_0 (16+3 k^2)^2}$	$\frac{4 \sqrt{3}}{16 a_0+3 a_0 k^2}$	$\frac{2 I \sqrt{6} k}{16 a_0+3 a_0 k^2}$	$-\frac{72 I k}{a_0 (16+3 k^2)^2}$	$\frac{8 I k (19+3 k^2)}{a_0 (16+3 k^2)^2}$	$-\frac{4 I \sqrt{2} k (19+3 k^2)}{a_0 (16+3 k^2)^2}$	0
$\mathcal{Q}^{\dagger} \mathcal{T}^{\parallel} \dagger$	$\frac{4 \sqrt{3}}{16 a_0+3 a_0 k^2}$	$\frac{4}{a_0 k^2}$	$\frac{2 I \sqrt{2}}{a_0 k}$	$\frac{8 I \sqrt{3}}{16 a_0 k+3 a_0 k^2}$	$-\frac{8 I}{\sqrt{3} (16 a_0 k+3 a_0 k^2)}$	$-\frac{8 I \sqrt{\frac{7}{3}}}{16 a_0 k+3 a_0 k^2}$	0
$\mathcal{Q}^{\dagger} \mathcal{W}_0^{\parallel} \dagger$	$-\frac{2 I \sqrt{6} k}{16 a_0+3 a_0 k^2}$	$-\frac{2 I \sqrt{2}}{a_0 k}$	0	$\frac{4 \sqrt{6}}{16 a_0+3 a_0 k^2}$	$-\frac{4 \sqrt{\frac{7}{3}}}{16 a_0+3 a_0 k^2}$	$-\frac{8}{\sqrt{3} (16 a_0+3 a_0 k^2)}$	0
$\mathcal{Q}^{\dagger} \mathcal{W}_5^{\perp \dagger}$	$\frac{72 I k}{a_0 (16+3 k^2)^2}$	$-\frac{8 I \sqrt{3}}{16 a_0 k+3 a_0 k^2}$	$\frac{4 \sqrt{6}}{16 a_0+3 a_0 k^2}$	$-\frac{144}{a_0 (16+3 k^2)^2}$	$\frac{16 (19+3 k^2)}{a_0 (16+3 k^2)^2}$	$-\frac{8 \sqrt{2} (19+3 k^2)}{a_0 (16+3 k^2)^2}$	0
$\mathcal{Q}^{\dagger} \mathcal{W}_5^{\parallel} \dagger$	$-\frac{8 I k (19+3 k^2)}{a_0 (16+3 k^2)^2}$	$\frac{8 I}{\sqrt{3} (16 a_0 k+3 a_0 k^2)}$	$-\frac{4 \sqrt{\frac{7}{3}}}{16 a_0+3 a_0 k^2}$	$\frac{16 (19+3 k^2)}{a_0 (16+3 k^2)^2}$	$-\frac{16 (35+6 k^2)}{3 a_0 (16+3 k^2)^2}$	$-\frac{8 \sqrt{2} (22+3 k^2)}{3 a_0 (16+3 k^2)^2}$	0
$\mathcal{Q}^{\dagger} \mathcal{W}_5^{\perp h} \dagger$	$\frac{4 I \sqrt{2} k (19+3 k^2)}{a_0 (16+3 k^2)^2}$	$\frac{8 I \sqrt{\frac{7}{3}}}{16 a_0 k+3 a_0 k^2}$	$-\frac{8}{\sqrt{3} (16 a_0+3 a_0 k^2)}$	$-\frac{8 \sqrt{2} (19+3 k^2)}{a_0 (16+3 k^2)^2}$	$-\frac{8 \sqrt{2} (22+3 k^2)}{3 a_0 (16+3 k^2)^2}$	$\frac{32 (19+3 k^2)}{3 a_0 (16+3 k^2)^2}$	0
$\mathcal{Q}^{\dagger} \mathcal{W}_0^{\parallel} \dagger$	0	0	0	0	0	$-\frac{2}{a_0}$	
$\mathcal{P}^{\dagger} \mathcal{W}_0^{\parallel} \dagger^{\alpha \beta}$	0	$-\frac{2 \sqrt{2}}{a_0}$	0	0	0	0	0
$\mathcal{P}^{\dagger} \mathcal{W}_0^{\perp} \dagger^{\alpha \beta}$	$-\frac{2 \sqrt{2}}{a_0}$	$\frac{2}{a_0-c_2 k^2}$	$-\frac{2 \sqrt{2} c_2 k^2}{a_0^2-a_0 c_2 k^2}$	0	0	0	0
$\mathcal{P}^{\dagger} \mathcal{W}_5^{\perp} \dagger^{\alpha \beta}$	0	$-\frac{2 \sqrt{2} c_2 k^2}{a_0^2-a_0 c_2 k^2}$	$\frac{4}{a_0-c_2 k^2}$	0	0	0	0
$\mathcal{P}^{\dagger} \mathcal{T}^{\perp} \dagger^{\alpha}$	0	0	0	$\frac{2 k^2}{a_0 (2+k^2)^2}$	$\frac{2 I \sqrt{2} k}{2 a_0+a_0 k^2}$	$\frac{I k (4+k^2)}{a_0 (2+k^2)^2}$	$-\frac{I \sqrt{\frac{7}{3}} k (4+3 k^2)}{a_0 (2+k^2)^2}$
$\mathcal{P}^{\dagger} \mathcal{W}_0^{\parallel} \dagger^{\alpha}$	0	0	0	$\frac{2 I \sqrt{2} k}{2 a_0+a_0 k^2}$	0	$\frac{\sqrt{2} (4+k^2)}{a_0 (2+k^2)}$	$-\frac{\sqrt{\frac{7}{3}} k^2}{2 a_0+a_0 k^2}$
$\mathcal{P}^{\dagger} \mathcal{W}_0^{\perp} \dagger^{\alpha}$	0	0	0	$-\frac{I k (4+k^2)}{a_0 (2+k^2)^2}$	$\frac{\sqrt{2} (4+k^2)}{a_0 (2+k^2)}$	$\frac{(4+k^2)^2}{2 a_0 (2+k^2)^2}$	$-\frac{\sqrt{\frac{107}{3}}}{a_0}$
$\mathcal{P}^{\dagger} \mathcal{W}_5^{\perp \dagger} \dagger^{\alpha}$	0	0	0	$\frac{I \sqrt{\frac{7}{3}} k (4+3 k^2)}{a_0 (2+k^2)^2}$	$-\frac{2 k^2}{\sqrt{3} (2 a_0+a_0 k^2)}$	$-\frac{8+8 k^2+k^4}{\sqrt{6} a_0 (2+k^2)^2}$	$\frac{1}{3} \left(-\frac{1}{c_2 k^2} + \frac{-16-8 k^2+k^4}{a_0 (2+k^2)^2} \right)$
$\mathcal{P}^{\dagger} \mathcal{W}_5^{\parallel \dagger} \dagger^{\alpha}$	0	0	0	0	0	$-\frac{\sqrt{\frac{107}{3}}}{a_0}$	$-\frac{\sqrt{5} (a_0-2 c_2 k^2)}{3 a_0 c_2 k^2}$
$\mathcal{P}^{\dagger} \mathcal{W}_5^{\perp h} \dagger^{\alpha}$	0	0	0	0	0	$-\frac{\sqrt{\frac{107}{3}}}{a_0}$	$-\frac{\sqrt{10} (a_0+c_2 k^2)}{3 a_0 c_2 k^2}$
$\mathcal{P}^{\dagger} \mathcal{W}_5^{\parallel h} \dagger^{\alpha}$	0	0	0	$\frac{I k (8+3 k^2)}{\sqrt{3} a_0 (2+k^2)^2}$	$\frac{\sqrt{\frac{7}{3}} k^2}{2 a_0+a_0 k^2}$	$\frac{-16-4 k^2+k^4}{2 \sqrt{3} a_0 (2+k^2)^2}$	$-\frac{2}{c_2 k^2} + \frac{-16-4 k^2+k^4}{a_0 (2+k^2)^2}$
$\mathcal{P}^{\dagger} \mathcal{W}_0^{\parallel h} \dagger^{\alpha}$	0	0	0	0	0	$-\frac{2 \sqrt{\frac{7}{3}}}{a_0}$	$\frac{4}{3 a_0} - \frac{2}{3 c_2 k^2}$
$\mathcal{P}^{\dagger} \mathcal{T}^{\parallel} \dagger^{\alpha \beta}$	$-\frac{8}{a_0 k^2}$	$-\frac{4 I \sqrt{2}}{a_0 k}$	$\frac{4 I}{\sqrt{3} a_0 k}$	$\frac{4 I \sqrt{\frac{7}{3}}}{a_0 k}$	0	0	0
$\mathcal{P}^{\dagger} \mathcal{W}_0^{\perp} \dagger^{\alpha \beta}$	$\frac{4 I \sqrt{2}}{a_0 k}$	0	$\frac{2 \sqrt{\frac{7}{3}}}{a_0}$	$\frac{4}{\sqrt{3} a_0}$	0	0	0
$\mathcal{P}^{\dagger} \mathcal{W}_5^{\parallel} \dagger^{\alpha \beta}$	$-\frac{4 I}{\sqrt{3} a_0 k}$	$\frac{2 \sqrt{\frac{7}{3}}}{a_0}$	$-\frac{8}{3 a_0}$	$-\frac{2 \sqrt{2}}{3 a_0}$	0	0	0
$\mathcal{P}^{\dagger} \mathcal{W}_5^{\perp} \dagger^{\alpha \beta}$	$-\frac{4 I \sqrt{\frac{7}{3}}}{a_0 k}$	$\frac{4}{\sqrt{3} a_0}$	$-\frac{2 \sqrt{2}}{3 a_0}$	$\frac{8}{3 a_0}$	0	0	0
$\mathcal{P}^{\dagger} \mathcal{W}_0^{\parallel} \dagger^{\alpha \beta \chi}$	0	0	0	0	$\frac{4}{a_0}$	0	0
$\mathcal{P}^{\dagger} \mathcal{W}_5^{\parallel} \dagger^{\alpha \beta \chi}$	0	0	0	0	0	$\frac{4}{a_0}$	$\mathcal{P}^{\dagger} \mathcal{W}_5^{\parallel} \dagger^{\alpha \beta \chi}$
						$\mathcal{P}^{\dagger} \mathcal{W}_5^{\parallel} \dagger^{\alpha \beta \chi}$	$-\frac{2}{a_0}$

Unitarity conditions

Spin-parity form	Covariant form	Multiplicities
$k^0 \cdot \mathcal{W}_5^{\parallel} + 2 k^0 \cdot \mathcal{W}_5^{\perp h} - 6 I^0 \mathcal{T}^{\perp} = 0$	$2 \partial_{\beta} \partial_{\alpha} \mathcal{T}^{\alpha \beta} + \partial_{\chi} \partial_{\alpha} \mathcal{W}^{\alpha \beta}{}_{\beta} = \partial_{\chi} \partial_{\beta} \partial_{\alpha} \mathcal{W}^{\alpha \beta \chi}$	1
$k^0 \cdot \mathcal{W}_5^{\perp \dagger} + 2 I^0 \mathcal{T}^{\perp} = 0$	$2 \partial_{\beta} \partial_{\alpha} \mathcal{T}^{\alpha \beta} = \partial_{\chi} \partial_{\beta} \partial_{\alpha} \mathcal{W}^{\alpha \beta \chi}$	1
$k^1 \cdot \mathcal{W}_5^{\perp h \alpha} - 6 I^1 \mathcal{T}^{\perp \alpha} = k \left(3 \cdot \mathcal{W}_5^{\perp \alpha} + \mathcal{W}_5^{\perp \dagger \alpha} \right)$	$2 \partial_{\chi} \partial_{\beta} \partial_{\alpha} \mathcal{T}^{\beta \chi} + \partial_{\delta} \partial^{\delta} \partial_{\chi} \partial_{\beta} \mathcal{W}^{\beta \alpha \chi} = 2 \partial_{\chi} \partial^{\chi} \partial_{\beta} \mathcal{T}^{\alpha \beta} + \partial_{\delta} \partial_{\chi} \partial_{\beta} \partial_{\alpha} \mathcal{W}^{\beta \alpha \delta}$	3
Total expected gauge generators:		5

Pole residue: $\frac{L^2}{c_2^2} > 0$

Square mass: $\frac{a_2}{c_2^2} > 0$

Spin: 1

Parity: Even

Pole residue: $\frac{L^2}{c_2^2} > 0$

Polarisations: 2

Pole residue: $\frac{1}{c_2} + \frac{8 c_2 k^4}{a_0^2} > 0$

Polarisations: 2

Pole residue: $\frac{L^2}{c_2^2} > 0$

Polarisations: 2

Pole residue: $\frac{L^2}{c_2^2} > 0$

Polarisations: 2

Pole residue: $\frac{L^2}{c_2^2} > 0$

Polarisations: 2

Pole residue: $\frac{L^2}{c_2^2} > 0$

Polarisations: 2

Pole residue: $\frac{L^2}{c_2^2} > 0$

Polarisations: 2

Pole residue: $\frac{L^2}{c_2^2} > 0$

Polarisations: 2

Pole residue: $\frac{L^2}{c_2^2} > 0$

Polarisations: 2

Demonstrably impossible