

Wave operator and propagator

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|--------------------------------------|---------------------------------|--------------------------------|----------------------------------|-----------------------------------|---------------------------------------|---|--------------------------------------|
| $\sigma_1^{\#1} \dagger \alpha\beta$ | 0 | $-\frac{\sqrt{2}}{t_1+k^2}t_1$ | $-\frac{i\sqrt{2}k}{t_1+k^2}t_1$ | 0 | 0 | 0 | 0 |
| $\sigma_1^{\#2} \dagger \alpha\beta$ | $-\frac{\sqrt{2}}{t_1+k^2}t_1$ | $\frac{1}{(1+k^2)^2}t_1$ | $\frac{ik}{(1+k^2)^2}t_1$ | 0 | 0 | 0 | 0 |
| $\tau_1^{\#1} \dagger \alpha\beta$ | $\frac{i\sqrt{2}k}{t_1+k^2}t_1$ | $-\frac{ik}{(1+k^2)^2}t_1$ | $\frac{k^2}{(1+k^2)^2}t_1$ | 0 | 0 | 0 | 0 |
| $\sigma_1^{\#1} \dagger \alpha$ | 0 | 0 | 0 | $\frac{6}{(3+4k^2)^2}t_1$ | $\frac{6\sqrt{2}}{(3+4k^2)^2}t_1$ | 0 | $\frac{12ik}{(3+4k^2)^2}t_1$ |
| $\sigma_1^{\#2} \dagger \alpha$ | 0 | 0 | 0 | $\frac{6\sqrt{2}}{(3+4k^2)^2}t_1$ | $\frac{12}{(3+4k^2)^2}t_1$ | 0 | $\frac{12i\sqrt{2}k}{(3+4k^2)^2}t_1$ |
| $\tau_1^{\#1} \dagger \alpha$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $\tau_1^{\#2} \dagger \alpha$ | 0 | 0 | 0 | $-\frac{12ik}{(3+4k^2)^2}t_1$ | $-\frac{12i\sqrt{2}k}{(3+4k^2)^2}t_1$ | 0 | $\frac{24k^2}{(3+4k^2)^2}t_1$ |

Quadratic (free) action

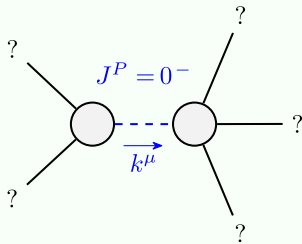
$$\begin{aligned}
S = & \iiint \left[\left(\frac{1}{6} (2 t_1 \omega_{\alpha}^{\alpha i} \omega_{\theta}^{\theta} + 6 f^{\alpha \beta} \tau_{\alpha \beta} + 6 \omega^{\alpha \beta X} \sigma_{\alpha \beta X} - 4 t_1 \omega_{\alpha}^{\theta} \partial_{\theta} f^{\alpha i} + 4 t_1 \omega_{\theta}^{\theta} \partial_{\theta} f^{\alpha i} \right. \right. \\
& \left. \left. \partial' f_{\alpha}^{\alpha} - 2 t_1 \partial_{\theta} f_{\theta}^{\theta} \partial' f_{\alpha}^{\alpha} - 2 t_1 \partial_{\theta} f_{\alpha}^{\alpha} \partial_{\theta} f_{\theta}^{\theta} + 4 t_1 \partial_{\theta} f_{\alpha}^{\alpha} \partial_{\theta} f_{\theta}^{\theta} - \right. \right. \\
& \left. \left. 6 t_1 \partial_{\alpha} f_{\theta}^{\theta} \partial_{\theta} f_{\theta}^{\theta} - 3 t_1 \partial_{\alpha} f_{\theta}^{\theta} \partial_{\theta} f_{\alpha}^{\alpha} + 3 t_1 \partial_{\theta} f_{\alpha}^{\alpha} \partial_{\theta} f_{\theta}^{\theta} + 3 t_1 \partial_{\theta} f_{\alpha}^{\alpha} \partial_{\theta} f_{\theta}^{\theta} + \right. \right. \\
& \left. \left. 3 t_1 \partial_{\theta} f_{\alpha}^{\alpha} \partial_{\theta} f_{\theta}^{\theta} + 6 t_1 \omega_{\alpha \theta}^{\alpha i} (\omega^{\alpha i \theta} + 2 \partial^{\theta} f^{\alpha i}) + 8 r_2 \partial_{\beta} \omega_{\alpha \theta}^{\theta} \partial^{\theta} \omega^{\alpha \beta i} - \right. \right. \\
& \left. \left. 4 r_2 \partial_{\beta} \omega_{\alpha \theta}^{\theta} \partial^{\theta} \omega^{\alpha \beta i} + 4 r_2 \partial_{\beta} \omega_{\theta \alpha}^{\theta} \partial^{\theta} \omega^{\alpha \beta i} - 2 r_2 \partial_{\theta} \omega_{\alpha \beta}^{\theta} \partial^{\theta} \omega^{\alpha \beta i} + \right. \right. \\
& \left. \left. 2 r_2 \partial_{\theta} \omega_{\alpha \beta}^{\theta} \partial^{\theta} \omega^{\alpha \beta i} - 4 r_2 \partial_{\theta} \omega_{\alpha \beta}^{\theta} \partial^{\theta} \omega^{\alpha \beta i} \right) [t, x, y, z] dz dy dx dt \right]
\end{aligned}$$

| $\omega_1^{\#1} + \alpha\beta$ | $\omega_1^{\#2} + \alpha\beta$ | $f_1^{\#1} + \alpha\beta$ | $\omega_1^{\#1} - \alpha$ | $\omega_1^{\#2} - \alpha$ | $f_1^{\#1} - \alpha$ | $f_1^{\#2} - \alpha$ |
|--------------------------------|--------------------------------|-----------------------------|---------------------------|---------------------------------|----------------------|--------------------------------|
| $-\frac{t_1}{2}$ | $-\frac{t_1}{\sqrt{2}}$ | $-\frac{i k t_1}{\sqrt{2}}$ | 0 | 0 | 0 | 0 |
| $-\frac{t_1}{\sqrt{2}}$ | 0 | 0 | 0 | 0 | 0 | 0 |
| $\frac{i k t_1}{\sqrt{2}}$ | 0 | 0 | 0 | 0 | 0 | 0 |
| $\omega_1^{\#1} + \alpha$ | 0 | 0 | $\frac{t_1}{6}$ | $\frac{t_1}{3\sqrt{2}}$ | 0 | $\frac{i k t_1}{3}$ |
| $\omega_1^{\#2} + \alpha$ | 0 | 0 | $\frac{t_1}{3\sqrt{2}}$ | $\frac{t_1}{3}$ | 0 | $\frac{1}{3} i \sqrt{2} k t_1$ |
| $f_1^{\#1} + \alpha$ | 0 | 0 | 0 | 0 | 0 | 0 |
| $f_1^{\#2} + \alpha$ | 0 | 0 | $-\frac{1}{3} i k t_1$ | $-\frac{1}{3} i \sqrt{2} k t_1$ | 0 | $\frac{2 k^2 t_1}{3}$ |

| Source constraints/gauge generators | |
|--|----------------|
| SO(3) irreps | Multiplicities |
| $\tau_{0+}^{\#2} == 0$ | 1 |
| $\tau_{0+}^{\#1} == 0$ | 1 |
| $\sigma_{0+}^{\#1} == 0$ | 1 |
| $\tau_1^{\#2\alpha} + 2ik \sigma_1^{\#1\alpha} == 0$ | 3 |
| $\tau_1^{\#1\alpha} == 0$ | 3 |
| $\sigma_1^{\#1\alpha} == \sigma_1^{\#2\alpha}$ | 3 |
| $\tau_1^{\#1\alpha\beta} + ik \sigma_1^{\#2\alpha\beta} == 0$ | 3 |
| $\tau_2^{\#1\alpha\beta} - 2ik \sigma_2^{\#1\alpha\beta} == 0$ | 5 |
| Total constraints: | 20 |

| | | | | | | | | | |
|------------------------------------|--------------------------------------|---------------------------------------|------------------------------------|-----------------|------------------------------------|---------------------------|----------------------------|------------------------------------|-----------------|
| $\sigma_2^{\#1} + \alpha\beta$ | $\frac{2}{(1+2k^2)^2 t_1}$ | $-\frac{2i\sqrt{2}k}{(1+2k^2)^2 t_1}$ | $\tau_2^{\#1} + \alpha\beta$ | 0 | $\omega_2^{\#1} + \alpha\beta$ | $\frac{t_1}{2}$ | $-\frac{ik t_1}{\sqrt{2}}$ | $f_2^{\#1} + \alpha\beta$ | 0 |
| $\tau_2^{\#1} + \alpha\beta$ | $\frac{2i\sqrt{2}k}{(1+2k^2)^2 t_1}$ | $\frac{4k^2}{(1+2k^2)^2 t_1}$ | $\sigma_2^{\#1} + \alpha\beta$ | 0 | $f_2^{\#1} + \alpha\beta$ | $\frac{ik t_1}{\sqrt{2}}$ | $k^2 t_1$ | $\omega_2^{\#1} + \alpha\beta$ | 0 |
| $\sigma_2^{\#1} + \alpha\beta\chi$ | 0 | 0 | $\sigma_2^{\#1} + \alpha\beta\chi$ | $\frac{2}{t_1}$ | $\omega_2^{\#1} + \alpha\beta\chi$ | 0 | 0 | $\omega_2^{\#1} + \alpha\beta\chi$ | $\frac{t_1}{2}$ |

Massive and massless spectra



| | |
|------------------|-----------------------|
| Massive particle | |
| Pole residue: | $-\frac{1}{r_2} > 0$ |
| Polarisations: | 1 |
| Square mass: | $\frac{t_1}{r_2} > 0$ |
| Spin: | 0 |
| Parity: | Odd |

(No massless particles)

Unitarity conditions

$$r_2 < 0 \ \&\& \ t_1 < 0$$