

## Wave operator and propagator

$$\begin{aligned}
& \text{Quadratic (free) action} \\
S = & \int \int \int \left( \frac{1}{6} (6 f^{\alpha\beta} \tau_{\alpha\beta} + 6 \omega^{\alpha\beta} \sigma_{\alpha\beta} - 3 r_3 \partial_\beta \omega_{\gamma\gamma}^\theta \partial_\theta \omega^{\alpha\beta} - 3 r_3 \partial_\gamma \omega_{\beta\theta}^\theta \partial^\gamma \omega^{\alpha\beta} - 3 \right. \\
& r_3 \partial_\alpha \omega^{\alpha\beta} \partial_\theta \omega_{\beta\gamma}^\theta + 6 r_3 \partial^\gamma \omega_{\gamma\gamma}^{\alpha\beta} \partial_\theta \omega_{\beta\gamma}^\theta - \\
& 3 r_3 \partial_\alpha \omega^{\alpha\beta} \partial_\theta \omega_{\beta\gamma}^\theta + 6 r_3 \partial^\gamma \omega_{\gamma\gamma}^{\alpha\beta} \partial_\theta \omega_{\beta\gamma}^\theta + \\
& 4 t_2 \omega_{\gamma\theta\alpha} \partial^\theta f^{\alpha\gamma} + 2 t_2 \partial_\alpha f_{\gamma\theta} \partial^\theta f^{\alpha\gamma} - t_2 \partial_\alpha f_{\theta\gamma} \partial^\theta f^{\alpha\gamma} - \\
& t_2 \partial_\gamma f_{\alpha\theta} \partial^\theta f^{\alpha\gamma} + t_2 \partial_\theta f_{\alpha\gamma} \partial^\theta f^{\alpha\gamma} - t_2 \partial_\theta f_{\gamma\alpha} \partial^\theta f^{\alpha\gamma} - \\
& 4 t_2 \omega_{\alpha\theta\gamma} (\omega^{\alpha\gamma\theta} + \partial^\theta f^{\alpha\gamma}) + 2 t_2 \omega_{\alpha\gamma\theta} (\omega^{\alpha\gamma\theta} + 2 \partial^\theta f^{\alpha\gamma}) + \\
& 8 r_2 \partial_\beta \omega_{\alpha\gamma\theta} \partial^\theta \omega^{\alpha\beta\gamma} - 4 r_2 \partial_\beta \omega_{\alpha\theta\gamma} \partial^\theta \omega^{\alpha\beta\gamma} + \\
& 4 r_2 \partial_\beta \omega_{\gamma\theta\alpha} \partial^\theta \omega^{\alpha\beta\gamma} - 24 r_3 \partial_\beta \omega_{\gamma\theta\alpha} \partial^\theta \omega^{\alpha\beta\gamma} - \\
& 2 r_2 \partial_\gamma \omega_{\alpha\beta\theta} \partial^\theta \omega^{\alpha\beta\gamma} + 2 r_2 \partial_\theta \omega_{\alpha\beta\gamma} \partial^\theta \omega^{\alpha\beta\gamma} - \\
& 4 r_2 \partial_\theta \omega_{\alpha\gamma\beta} \partial^\theta \omega^{\alpha\beta\gamma} + 6 r_5 \partial_\gamma \omega_{\theta\gamma}^\kappa \partial^\theta \omega^{\alpha\gamma} - \\
& 6 r_5 \partial_\theta \omega_{\gamma\gamma}^\kappa \partial^\theta \omega^{\alpha\gamma} - 6 r_5 \partial_\alpha \omega^{\alpha\gamma\theta} \partial_\gamma \omega_{\gamma\theta}^\kappa + \\
& 12 r_5 \partial^\theta \omega^{\alpha\gamma} \partial_\gamma \omega_{\gamma\theta}^\kappa + 6 r_5 \partial_\alpha \omega^{\alpha\gamma\theta} \partial_\gamma \omega_{\theta\gamma}^\kappa - \\
& 12 r_5 \partial^\theta \omega^{\alpha\gamma} \partial_\gamma \omega_{\theta\gamma}^\kappa ) [t, x, y, z] dz dy dx dt
\end{aligned}$$

Quadratic pole	
Pole residue:	$-\frac{1}{r_3(2r_3+r_5)(r_3+2r_5)p^2} > 0$
Polarisations:	2

$$r_2 < 0 \& r_3 < 0 \& r_5 < -\frac{r_3}{2} \& t_2 > 0 \parallel r_2 < 0 \& r_3 < 0 \& r_5 > -2r_3 \& t_2 > 0 \parallel r_2 < 0 \& r_3 > 0 \& -2r_3 < r_5 < -\frac{r_3}{2} \& t_2 > 0$$

$k^2(2r_3+r_5)+\frac{2t_2}{3}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{1}{3}i\sqrt{2}kt_2$	0	0	0	0
$\frac{\sqrt{2}t_2}{3}$	$\frac{t_2}{3}$	$\frac{t_2}{3}$	$\frac{ikt_2}{3}$	0	0	0	0
$-\frac{1}{3}i\sqrt{2}kt_2$	$-\frac{1}{3}ikt_2$	$\frac{k^2t_2}{3}$	$\frac{k^2t_2}{3}$	0	0	0	0
0	0	0	$\frac{1}{2}k^2(r_3+2r_5)$	$\frac{1}{2}k^2(r_3+2r_5)$	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

$\sigma_0^{\#1} +$	$\tau_0^{\#1} +$	$\tau_0^{\#2} +$	$\sigma_0^{\#1}$
0	0	0	0
$\tau_0^{\#1} +$	0	0	0
$\tau_0^{\#2} +$	0	0	0
$\sigma_0^{\#-1} +$	0	0	$\frac{1}{k^2 r_2 + t_2}$

  

$\omega_{2+}^{\#1} \alpha_\beta$	$f_{2+}^{\#1} \alpha_\beta$	$\omega_{2-}^{\#1} \alpha_\beta \chi$
$-\frac{3 k^2 r_3}{2}$	0	0
$f_{2+}^{\#2} + \alpha_\beta$	0	0
$\omega_{2-}^{\#1} + \alpha_\beta \chi$	0	0

  

$\sigma_2^{\#1} + \alpha_\beta$	$\tau_2^{\#1} + \alpha_\beta$	$\sigma_2^{\#1} \alpha_\beta \chi$
$-\frac{2}{3 k^2 r_3}$	0	0
$\sigma_2^{\#1} + \alpha_\beta$	0	0
$\sigma_2^{\#1} + \alpha_\beta \chi$	0	0

  

$\omega_0^{\#1}$	$\tau_0^{\#2}$	$\omega_0^{\#-1}$	$t_2$
0	0	0	$k^2 r_2 + t_2$
0	0	0	0
0	0	0	0
0	0	0	0