

# Particle spectrograph

## Wave operator and propagator

Quadratic (free) action

$S =$

$$\int \int \int \int (\beta h_{\alpha\beta} h^{\alpha\beta} - \gamma h^\alpha_\alpha h^\beta_\beta + h^{\alpha\beta} \mathcal{T}_{\alpha\beta} + \frac{1}{2} \alpha (\partial_\beta h^\chi_\chi \partial^\beta h^\alpha_\alpha + 2 \partial_\alpha h^{\alpha\beta} \partial_\chi h^\chi_\beta - 2 \partial^\beta h^\alpha_\alpha \partial_\chi h^\chi_\beta - \partial_\chi h_{\alpha\beta} \partial^\chi h^{\alpha\beta})) [t, x, y, z] dz dy dx dt$$

$\mathcal{T}_{0+}^{\#1} \dagger$ 

$\frac{1}{\frac{\beta(\beta-4\gamma)}{\beta-\gamma} + \alpha k^2}$	$\frac{\sqrt{3}\gamma}{\beta(\beta-4\gamma) + \alpha(\beta-\gamma)k^2}$
$\frac{\sqrt{3}\gamma}{\beta(\beta-4\gamma) + \alpha(\beta-\gamma)k^2}$	$\frac{1}{\beta + \gamma(-1 - \frac{3\gamma}{\beta-3\gamma + \alpha k^2})}$

$\mathcal{T}_{0+}^{\#2} \dagger$ 

$\frac{\sqrt{3}\gamma}{\beta(\beta-4\gamma) + \alpha(\beta-\gamma)k^2}$	$\frac{1}{\beta + \gamma(-1 - \frac{3\gamma}{\beta-3\gamma + \alpha k^2})}$
$\frac{1}{\frac{\beta(\beta-4\gamma)}{\beta-\gamma} + \alpha k^2}$	$\frac{\sqrt{3}\gamma}{\beta(\beta-4\gamma) + \alpha(\beta-\gamma)k^2}$

(No source constraints)

$h_{0+}^{\#1} \dagger$ 

$\beta - 3\gamma + \alpha k^2$	$-\sqrt{3}\gamma$
$-\sqrt{3}\gamma$	$\beta - \gamma$

$h_{0+}^{\#2} \dagger$ 

$\beta - 3\gamma + \alpha k^2$	$-\sqrt{3}\gamma$
$-\sqrt{3}\gamma$	$\beta - \gamma$

$\mathcal{T}_{1-}^{\#1} \dagger^\alpha$ 

$\frac{1}{\beta}$
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$\mathcal{T}_{1-}^{\#1} \dagger^\alpha$ 

$\beta$
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$\mathcal{T}_{2+}^{\#1} \dagger^{\alpha\beta}$ 

$\frac{1}{\beta - \frac{\alpha k^2}{2}}$
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$h_{2+}^{\#1} \dagger^{\alpha\beta}$ 

$\beta - \frac{\alpha k^2}{2}$
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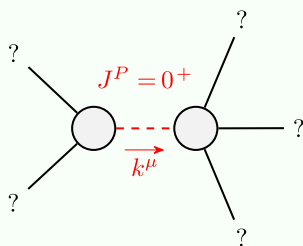
$h_{1-}^{\#1} \dagger^\alpha$ 

$\beta$
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$h_{1-}^{\#1} \dagger^\alpha$ 

$\beta$
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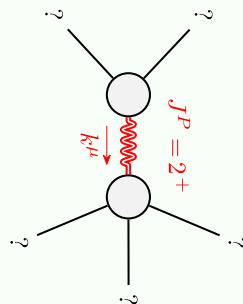
## Massive and massless spectra



Massive particle

Pole residue:	$\frac{\beta^2 - 2\beta\gamma + 4\gamma^2}{\alpha(\beta-\gamma)^2} > 0$
Polarisations:	1
Square mass:	$-\frac{\beta(\beta-4\gamma)}{\alpha(\beta-\gamma)} > 0$
Spin:	0
Parity:	Even

(No massless particles)



Massive particle	
Pole residue:	$-\frac{2\beta}{\alpha} > 0$
Polarisations:	5
Square mass:	$\frac{2\beta}{\alpha} > 0$
Spin:	2
Parity:	Even

## Unitarity conditions

(Unitarity is demonstrably impossible)