

# Particle spectrograph

## Wave operator and propagator

Quadratic (free) action

$$S = \iiint (\gamma \mathcal{B}_\alpha \mathcal{B}^\alpha + \mathcal{B}^\alpha \mathcal{J}_\alpha + \beta \partial_\alpha \mathcal{B}^\alpha \partial_\beta \mathcal{B}^\beta + \alpha \partial_\beta \mathcal{B}_\alpha \partial^\beta \mathcal{B}^\alpha) [t, x, y, z] dz dy dx dt$$

$\mathcal{B}_{0+}^{\#1} + \boxed{\gamma + (\alpha + \beta) k^2}$

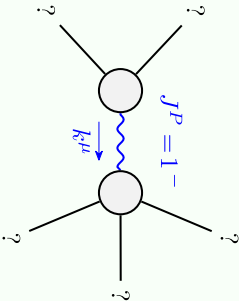
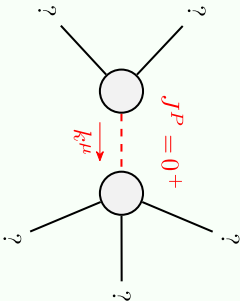
$\mathcal{J}_{0+}^{\#1} + \boxed{\frac{1}{\gamma + (\alpha + \beta) k^2}}$

$\mathcal{B}_{1-}^{\#1} + \alpha \boxed{\gamma + \alpha k^2}$

$\mathcal{J}_{1-}^{\#1} + \alpha \boxed{\frac{1}{\gamma + \alpha k^2}}$

(No source constraints)

## Massive and massless spectra



(No massless particles)

Massive particle	
Pole residue:	$\frac{1}{\alpha + \beta} > 0$
Polarisations:	1
Square mass:	$-\frac{\gamma}{\alpha + \beta} > 0$
Spin:	0
Parity:	Even

Massive particle	
Pole residue:	$-\frac{1}{\alpha} > 0$
Polarisations:	3
Square mass:	$-\frac{\gamma}{\alpha} > 0$
Spin:	1
Parity:	Odd

## Unitarity conditions

(Unitarity is demonstrably impossible)