

Particle spectrograph

Wave operator and propagator

```
xAct\PSALter\Private\GraphicsCollage[
```

$$\begin{aligned}
 & \begin{matrix} \omega_{0+}^{\#1} & f_{0+}^{\#1} & f_{0+}^{\#2} & \omega_{0-}^{\#1} \end{matrix} \\
 & \left\{ \begin{matrix} \omega_{0+}^{\#1} \dagger \\ f_{0+}^{\#1} \dagger \\ f_{0+}^{\#2} \dagger \\ \omega_{0-}^{\#1} \dagger \end{matrix} \right. \begin{array}{|c|c|c|c|} \hline 6k^2 r_3 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & k^2 r_2 + t_2 \\ \hline \end{array} \right. , \\
 \\
 \text{Join} [& \begin{array}{|c|c|c|c|c|c|c|} \hline \frac{2t_2}{3} & \frac{\sqrt{2}t_2}{3} & \frac{1}{3}i\sqrt{2}kt_2 & 0 & 0 & 0 & 0 \\ \hline \frac{\sqrt{2}t_2}{3} & \frac{t_2}{3} & \frac{ikt_2}{3} & 0 & 0 & 0 & 0 \\ \hline -\frac{1}{3}i\sqrt{2}kt_2 & -\frac{1}{3}ikt_2 & \frac{k^2t_2}{3} & 0 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \hline \end{array} , \\
 & \begin{matrix} \omega_{2+}^{\#1}{}_{\alpha\beta} & f_{2+}^{\#1}{}_{\alpha\beta} & \omega_{2-}^{\#1}{}_{\alpha\beta\chi} \end{matrix} \\
 & \left\{ \begin{matrix} \omega_{2+}^{\#1} \dagger{}^{\alpha\beta} \\ f_{2+}^{\#1} \dagger{}^{\alpha\beta} \\ \omega_{2-}^{\#1} \dagger{}^{\alpha\beta\chi} \end{matrix} \right. \begin{array}{|c|c|c|} \hline 0 & 0 & 0 \\ \hline 0 & 0 & 0 \\ \hline 0 & 0 & 0 \\ \hline \end{array} \right.
 \end{aligned}$$

```
{AspectRatio → Automatic}], Join[656, {AspectRatio → Automatic}, {Null, Null}, {500}]
```

Massive and massless spectra

```
xAct`PSALter`Private`GraphicsCollage[{Null, Null},
  Join[656, {AspectRatio → Automatic}, {Null, Null}, {500}]]
```

Unitarity conditions

