

$$\text{constraint } \underline{L}_0 - \bar{L}_0 = 1 \underline{\mathbf{x}} \underline{L} \underline{\mathbf{x}} \bar{i} - i \underline{\mathbf{x}} \bar{L}$$

$$\text{Hamiltonian } \underline{L}_0 + \bar{L}_0 - 2 = P^2 \underline{\mathbf{x}} i \underline{\mathbf{x}} \bar{i} + 1 \underline{\mathbf{x}} \underline{L} - i \underline{\mathbf{x}} \bar{i} + 1 \underline{\mathbf{x}} i \underline{\mathbf{x}} \bar{L} - \bar{i}$$

$$\begin{aligned} \text{LHS} &= P^2 / 2 \underline{\mathbf{x}} i \underline{\mathbf{x}} \bar{i} + 1 \underline{\mathbf{x}} \underline{L} \underline{\mathbf{x}} \bar{i} + P^2 / 2 \underline{\mathbf{x}} i \underline{\mathbf{x}} \bar{i} + 1 \underline{\mathbf{x}} i \underline{\mathbf{x}} \bar{L} - 2 \underline{\mathbf{x}} i \underline{\mathbf{x}} \bar{i} \\ &= P^2 \underline{\mathbf{x}} i \underline{\mathbf{x}} \bar{i} + 1 \underline{\mathbf{x}} \underline{L} \underline{\mathbf{x}} \bar{i} - 1 \underline{\mathbf{x}} i \underline{\mathbf{x}} \bar{i} + 1 \underline{\mathbf{x}} i \underline{\mathbf{x}} \bar{L} - 1 \underline{\mathbf{x}} i \underline{\mathbf{x}} \bar{i} = \text{RHS} \end{aligned}$$

$$z^{\underline{L}_0 + \bar{L}_0 - 2} = z^{P^2} \underline{\mathbf{x}} z^{\underline{L} - i} \underline{\mathbf{x}} z^{\bar{L} - i}$$

$$\text{poles of prop=phys states } \underline{L}_0 + \bar{L}_0 - 2 \Phi = 0$$

$$\text{constraint } \underline{L}_0 - \bar{L}_0 \Phi = 0: \underline{\mathcal{F}} \underline{\mathbf{x}} \bar{\mathcal{F}}$$

$$z = r e^{it}$$

$$\underline{z}^{\underline{L} \underline{\mathbf{x}} \bar{z}^{\bar{L}}} \underline{\mathcal{F}} \underline{\mathbf{x}} \bar{\mathcal{F}} \sqsubset \underline{\mathcal{F}} \underline{\mathbf{x}} \bar{\mathcal{F}}$$

$$\underline{z}^{\underline{L} \underline{\mathbf{x}} \bar{z}^{\bar{L}}} \underline{L} \underline{\mathbf{x}} \bar{i} - i \underline{\mathbf{x}} \bar{L} = \underline{z}^{\underline{L} \underline{L}} \underline{\mathbf{x}} \bar{z}^{\bar{L}} - \underline{z}^{\underline{L}} \underline{\mathbf{x}} \bar{z}^{\bar{L} \bar{L}}$$

$$\underline{L} \underline{\mathbf{x}} \bar{i} - i \underline{\mathbf{x}} \bar{L} \underline{z}^{\underline{L} \underline{\mathbf{x}} \bar{z}^{\bar{L}}} = \underline{L} \underline{z}^{\underline{L}} \underline{\mathbf{x}} \bar{z}^{\bar{L}} - \underline{z}^{\underline{L}} \underline{\mathbf{x}} \bar{L} \bar{z}^{\bar{L}}$$

$$\int_{dz/z \bar{z}}^{\mathbb{B}/4\pi} \underline{z}^{\underline{L}_0 - 1} \bar{z}^{\bar{L}_0 - 1} = \int_{dz/z \bar{z}}^{\mathbb{B}/4\pi} \underbrace{\sqrt{\underline{z}}^{P^2} \underline{\mathbf{x}} \underline{z}^{\underline{L} - 1} \underline{\mathbf{x}} \bar{i}}_{\sqrt{\underline{z}}^{P^2} \underline{\mathbf{x}} i \underline{\mathbf{x}} \bar{z}^{\bar{L} - 1}} = \int_{dz/z \bar{z}}^{\mathbb{B}/4\pi} \bar{z}^{P^2} \underline{\mathbf{x}} \underline{z}^{\underline{L} - 1} \underline{\mathbf{x}} \bar{z}^{\bar{L} - 1}$$

$$\frac{1}{2} \overbrace{L + \bar{L} - 2}^{-1} = \frac{1}{2} \int_{dr}^{0|1} r^{L + \bar{L} - 3} \int_{dt/2\pi}^{0|\pi} e^{it(L - \bar{L})}$$