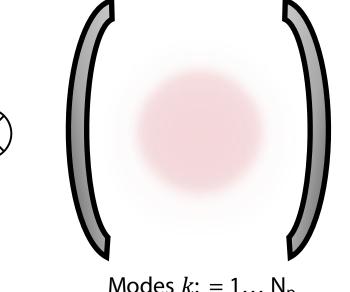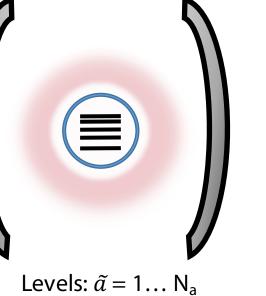Exact: many virtual excitations
of bare atom and cavity photons

Approximate: few virtual excitations
of effective atom and cavity photons

Levels: $a = 1 \ldots N_a$

Modes k: $= 1 \ldots N_p$

Levels: $\tilde{a} = 1 \ldots N_a$

Modes $\tilde{k}$: $= 1 \ldots N_p$

$$\otimes$$

$$\approx$$

$$|\Psi\rangle = \sum_{a=0}^{N_a} \sum_{n_1 \cdots n_{N_p}=0}^{\infty} c_{a;n_1 \cdots n_{N_p}} |a\rangle \otimes |n_1 \cdots n_N\rangle$$

$$|\Psi\rangle \approx |\tilde{g}\rangle \otimes |\tilde{0}\rangle + \sum_{\tilde{a}=1}^{N_a} \sum_{\tilde{k}=1}^{N_p} c_{\tilde{a};\tilde{k}} |\tilde{a}\rangle \otimes |\tilde{1}_{\tilde{k}}\rangle$$