

Variational theory of the ground state of cavity quantum electrodynamics

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I. VARIATIONAL ANSATZ

A. Concept: Effectively non-interacting matter and photon systems

B. Correlation corrections coming from virtual matter and photon quasiparticles

II. APPLICATION TO A MULTI-LEVEL SYSTEM COUPLED TO A MULTI-MODE CAVITY

III. OUTLOOK

IV. ACKNOWLEDGEMENTS

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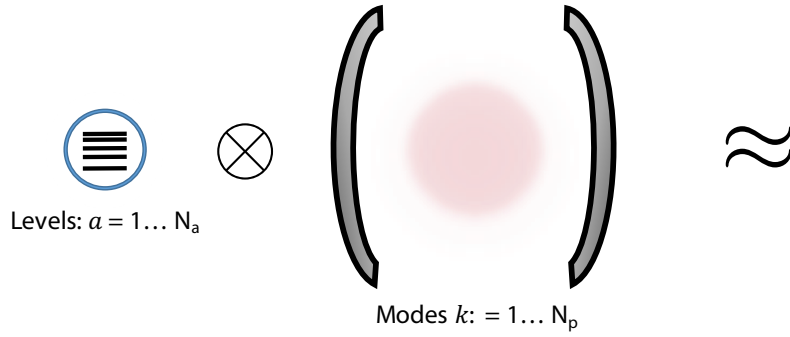
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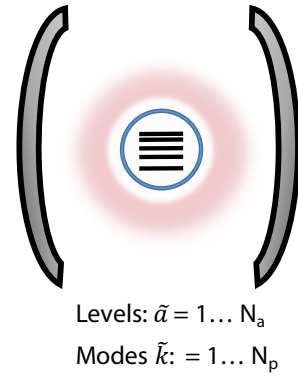
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Exact: many virtual excitations
of bare atom and cavity photons



Approximate: few virtual excitations
of effective atom and cavity photons



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

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

Fig. 1. Ground-state ansatz applied to matter in a cavity: effectively decoupled matter and photons. .