

***Time-dependent density functional theory for many-electron systems***

***interacting with photons: tddft for cavity-qed***

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Experimental progress in the fields of cavity and circuit quantum electrodynamics (QED) opens

a possibility to study many-electron systems strongly interacting with quantum light.

Obviously,

the classical treatment of external fields prevents application of the standard TDDFT to this new

class of problems. Here I present a generalization of TDDFT for many-electron systems strongly

coupled to quantum electromagnetic modes of a microcavity. I show that the full electron-photon

wave function is a unique functional of the electronic (current) density and the expectation

values of photonic coordinates. The Kohn-Sham system is constructed, which allows to

calculate the above basic variables by solving selfconsistent equations for noninteracting

particles. I suggest possible strategies for approximating exchange-correlation potentials and

discuss implications of this approach for the theory of open quantum systems. In particular, I

show that it naturally leads to TDDFT for many-particle systems coupled to the Caldeira-Leggett

bath of harmonic oscillators.