# Dyson-Schwinger Equations in Scalar Electrodynamics

A V Berezin[1], A A Mironov[1,2], E S Sozinov[1], and A M Fedotov[1]

[1] *Theoretical Nuclear Physics, National Research Nuclear University (MEPhI), 31, Kashirskoe Shosse, 115409, Moscow, Russia*

[2] *Theoretical department, A M Prokhorov General Physics Institute of RAS, 38, Vavilova St, 119991, Moscow, Russia*

Contact Email: arsenbrs@mail.ru

Quantum electrodynamics (QED) is a theory of the interacting fermionic electron-positron and electromagnetic fields. However, it may be expedient to isolate or neglect the contribution of the spin effects. Also, there do exist charged scalar particles. Therefore, it is worth studying a scalar version of QED as well. At first glance, such a theory should be simpler due to the absence of spin degrees of freedom. However, it turns out that due to the gauge invariance, it contains an extra interaction (bare vertex) as compared to the standard fermionic QED.

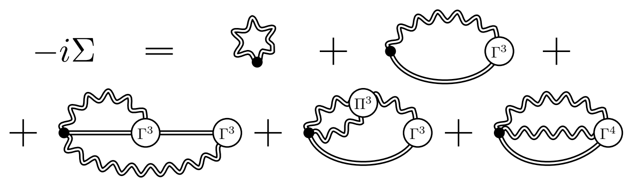


Figure 1: Contributions to the mass operator in strong field scalar QED. $\Pi^3$ denotes the exact three-photon vertex

One of the most important QED equations is the Dyson-Schwinger (DS) equations, establishing a relationship between the exact (i.e. dressed by radiative corrections) propagators and vertices. In particular, they are used to construct nonperturbative methods based on partial resummations of the perturbative series.

We obtain analogs of the DS equations for scalar QED in an external electromagnetic field and discuss a diagrammatic interpretation of the corresponding mass and polarization operators. We use functional integration techniques, which is especially convenient to derive and analyze general properties and relations. In this approach, the main object is a generating functional, which is an amplitude of vacuum-vacuum transition in the presence of classical sources. It generates the full set of Green functions and obeys functional equations called the quantum equations of motion.

The DS equations are obtained by taking extra variational derivatives of these equations with respect to sources after expressing the result in terms of the exact propagators and vertices. After that, we set scalar sources to zero but, allowing the presence of an external electromagnetic field, leave the corresponding source unconstrained. The resulting equations have a much more bulky structure than in standard QED. In particular, in the presence of an external field, the mass operator contains the contribution of an exact three-photon vertex (see Fig. 1), which was not pointed out previously in the literature.