-representation in quantum optics and anomalous polarization operators [[1]](#footnote-1)\*)

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The kinetics of the electromagnetic field in an extended medium of single-valent atoms is considered. The solution of the problem by the methods of semi-classical radiation theory, operating with a non-quantized electromagnetic field and Maxwell's equations, is often sufficient in applied problems. The semi-classical theory of radiation is not logically closed and therefore no corrections can be derived to it. We aim to draw attention to the fundamentally new optical processes predicted consistently by quantum theory of radiation.

The study is carried out, as usual, by the method of quantum Green's functions using the L.V.Keldysh formalism. There is a weakness in this method. In the process of derivation of closed-form equations for quantum Green's functions correlators of higher orders are approximated by combinations of correlators of the second order by using thermodynamic version of Wick's theorem. It means that all physical processes determined by higher correlators fall out of consideration and we obtain, as a rule, results of semiclassical theory of radiation. To exclude this problem we propose the method of -operators operating not with separate photons, but with a conglomerate of photons as a whole. Here -wave vector, -linear polarization index,  -number of photons in a single mode . The vector characterizes the state of the photon subsystem in the multidimensional dummy space.

In the mentioned formalism it is possible to express the density matrix of the photon subsystem in the form , where - is a part of the density matrix admitting the representation through the wave functions . The matrix describes a part of the density matrix not allowing such representation. The function  satisfies the equation , where -wave function in absence of interaction,  -time delayed polarization operator. It turns out that . The normal polarization operator , with some corrections, is responsible for the known optical processes. Anomalous polarization operator is responsible for unknown optical processes determined by correlators of higher orders.

A function-defining equation has many solutions. These solutions depend on the function. If in the absence of interaction  the photon system consists of only one mode, then after the including of the interaction in the system there appears a bounded photon pair of oppositely directed photons having zero energy and zero polarization. The amplitude of this pair is determined in the first approximation by the concentration of excited atoms and does not depend on the concentration of atoms in the normal state. If before the interaction in the photon subsystem two opposite directed modes were filled, then the solution of the problem changes in principle. It becomes dependent on the concentration of atoms in the unexcited state.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLIX/Lt/ru/EC-Veklenko.docx) [↑](#footnote-ref-1)