Bound States of Photon Pairs as a Consequence of the Processes of Coherent Spontaneous and Coherent Induced Radiation [[1]](#footnote-1)\*)

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Modern methods for studying optical problems in dispersed media use the formalism of secondary quantization. The basic equations of this formalism are well known. The photon kinetics is described here by the Schrodinger equation. If we are talking about perturbation theory, then there are no problems. However, when studying the kinetics of a set of photons in dispersed media, it becomes necessary to force breaking of quantum correlators. Errors in this case may exceed the main result.

Currently, there are two methods for solving the equations of quantum electrodynamics in the presence of many particles (photons) in the system. The first method uses perturbation theory and then replaces Wick's algebraic theorem with its thermodynamic version. The second one uses the Bogolyubov chain method followed by forced breaking of higher-order correlators. In fact, both the first method and the second use a forced procedure for breaking quantum correlators and replacing higher-order correlators with lower-order correlators. The limited application of the thermodynamic version of Wick's theorem can be seen from its consequences. One of these consequences is the Dyson equation for quantum two-particle Green functions. This equation is closed with respect to two-particle Green functions, and does not contain higher-order Green functions. Such an equation cannot be universal, and is valid either under the assumption of a Gaussian distribution of the studied objects, or under the forced neglect of higher-order correlators.

In [1], a method of Г –operators was proposed to avoid this difficulty. It was shown [2] that the method of Г-operators is equivalent to the mathematical apparatus that occurs in the tertiary quantization of secondary quantized equations.

In this information, we note that the Г –operator method, which takes into account higher-order quantum correlators, makes it possible to find currently unknown solutions to the basic equations of quantum optics. One of these solutions describes the process of coherent stimulated emission of bound photon pairs in a Maxwell gas at elevated temperature. There is no such process in a vacuum. As a result of this radiation, the excited atoms generating the process continue to remain in the initial excited state. The resulting photon pairs have zero energy and zero momentum. For this reason, their energy is less than the energy of free photons, and the wave vectors in photon pairs are mutually opposite. The polarization vectors of photons in pairs are also directed in opposite directions.

If there are no photons provoking induced radiation, the process of coherent spontaneous emission of photon pairs remains. As a result of such processes, the excited atoms do not change their initial state, and therefore, in the quantum sense, these processes are coherent.

References

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2. Veklenko B. A. Journal of Physics: Conference Series 1647 (2020) 01 2016. doi:10.1088/1742-6596/1647/1/012016

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