Fluorescence and amplification in quantum systems with violated symmetry

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One-electron multi-level atom model with violated symmetry, driven by external semi-classical monochromatic high-frequency electromagnetic field and interacting with a heat bath simultaneously, was studied under the assumption that its transition dipole operator possesses permanent diagonal matrix elements and not all of them are equal to each other, which assumption amounts to the violation of the spatial inversion symmetry. A general formula for the intensity of the electromagnetic field radiated from such a system in the far-distant zone was derived which does not contain contributions stemming from these non-zero permanent diagonal matrix elements of the transition dipole moments explicitly. Hence, it can be concluded that the dynamics of these diagonal matrix elements may affect the system fluorescence only indirectly through the alteration of the time dependence of the non-diagonal matrix elements due to quantum processes of higher orders. As an example, radiative properties of a monochromatically driven two-level quantum system with permanent non-equal dipole moment diagonal matrix elements were thoroughly analyzed. The central part of this work results are the (plausible) conditions under which this system driven by external monochromatic high-frequency laser field can radiate continuously at much lower frequency. It was also discussed how such a system could be realized in practice. The absorption-amplification response to the weak probe field in this system driven by external laser field at resonant frequency was studied too. It was found that this system is able to amplify low-frequency EM radiation for a broad enough range of frequencies. It is reasonable to assume that these results may be of use in various fields of nano-electronics and can be employed in development of practically useful devices dedicated for generation and amplification of relatively low-frequency (terahertz) EM radiation.

Speaker Biography

Nikolai Bogolubov is a chief scientific researcher at the VA Steklov Mathematical Institute of the RAS. His scientific interests are in general mathematical problems of equilibrium and non-equilibrium statistical mechanics and applications of modern mathematical methods of classical and quantum statistical mechanics to the problems of the polaron theory, super radiance theory, and the theory of superconductivity. His main works belong to the field of Theoretical and Mathematical Physics, Classical and Quantum Statistical Mechanics, Kinetic theory. He has published more than 150 works in the field of Statistical Mechanics, Theoretical and Mathematical Physics.

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