MEDWIN PUBLISHERS
Committed to Create Value for Researchers

Physical Science & Biophysics Journal
ISSN: 2641-9165

The Latest Developments of the our Scientific Group of Kharkov University

Kuklin VM*

Kharkiv National University, Ukraine

***Corresponding author:** Volodymyr Mykhailovych Kuklin, Kharkiv National University, Ukraine, Email: kuklinvm1@gmail.com

Short Communication

Volume 6 Issue 2

Received Date: October 06, 2022

Published Date: October 12, 2022

DOI: 10.23880/psbj-16000218

Short Communication

Interest in the processes of generation of oscillations in super radiance regimes began with the well-known work by Dicke RN [1]. Super radiance is usually realized in open systems when high-frequency energy is removed from the system. To a certain extent, this energy release can be equivalent to dissipative processes of a distributed type. Previously, dissipative regimes of excitation or generation of an electromagnetic wave in open waveguide resonator systems such as a traveling wave lamp traditionally corresponded to the case of interaction of a waveguide electromagnetic field with radiating particles, most often with moving beam electrons (see example [2]) or oscillators. Since the system is open, the field leaves the waveguide, which for short systems is equivalent to losses or dissipative processes of a distributed type. The field damping factor in such a waveguide or resonator without emitters or generators for such generation or amplification modes can be greater than the development increment of the generation process in the presence only these active elements without dissipation or losses [3–5]. In particular, we can consider the case of the interaction of a system of fixed oscillators with the field of an open resonator. In this case, the oscillators did not interact directly with each other, but only through the resonator field common to the system.

The superradiance regime (see, for example, [1,6,7]), on the contrary, ensured precisely the interaction of oscillators with each other, both with the nearest neighbours and with all other oscillators in the system. In this case, due to sufficiently large distances between the particles, the interaction between them occurs only due to their own electromagnetic fields. The mechanism of phase locking of radiation from such generators was discussed in Kuklin VM, et al. [8-10].

Attempts to find similarities between dissipative instability regimes and super radiance in open systems began in Kuklin VM, et al. [11,12]. It is noteworthy that the systems of equations describing the interaction of electron beams rotating in a magnetic field with the fields of a waveguide at cyclotron resonances, when simplified, were reduced to a description of the interaction of oscillators considered in the above papers [13]. This circumstance indicated the existence of a mechanism of phase synchronization common to all these cases. A detailed comparison was made of the dissipative mode of field generation in an open resonator system with the super radiance mode in the same resonator uniformly filled with motionless excited oscillators. The analysis showed that the increments of the processes and the maximum achievable amplitudes of the field of these two regimes practically coincide [14]. If this resonator is filled with an active quantum medium, then a dissipative excitation regime is also possible, in which quantum oscillators interact only with the resonator field, and there is no direct interaction between them. We also discuss the regime of super radiance in such a resonator, when quantum oscillators interact only with each other. It is important to note that at a relatively low density of oscillators, their wave functions did not overlap [15], therefore, they can affect each other only by their own radiation fields. And here, the characteristic times of the processes and the maximum achievable field amplitudes of these two regimes practically coincided [16].

It is useful to transfer further development of super radiance studies to the gamma and ultraviolet regions[1],

1 Masers with mirrors cannot be used in these systems, since such mirrors simply do not exist, so quantum and classical oscillators are possible in this frequency range only in super luminescence or super radiance modes. Masers with mirrors cannot be used in these systems, since such mirrors simply do not exist, so quantum and classical oscillators are possible in this frequency range only in super luminescence or super radiance modes.

where it is necessary to consider: the behaviour of oscillators in motion under the action of RF pressure (as was done in [17]); and explore a more realistic model of super radiance that can be offered to experimenters.

References

1. Dicke RH (1954) Coherence in Spontaneous Radiation Processes. Phys Rev 93(1): 99-110.

2. Kirichok AV, Kuklin VM, Mischin AV, Pryimak AV (2015) Modelling of superradiation processes driven by an ultra-short bunch of charged particles moving through a plasma. Problems of Atomic Science and Technology 98(4): 255-257.

3. Briggs RJ (1964) Electron-stream interaction with plasmas. Cambridge MIT Press, USA.

4. Abramovich, Shevchenko VI (1972) To the nonlinear theory of dissipative instability of a relativistic beam in plasma. ZhETF 62(4): 1386-1391.

5. Kondratenko AN, Kuklin VM, Tkachenko VI (1979) On the anomalous level of beam energy loss during the development of dissipative beam instability. Ukrainian Physical Journal 24(4): 559-561.

6. Andreev AV, Emelyanov VI, Il'inskiy YuA Collective spontaneous radiation (Dicke radiation). Phys 131(4): 655-694.

7. Zheleznyakov VV, Kocharovsky VV (1989) Polarization waves and superradiance in active media. UFN 159(2): 193-260.

8. Kuklin VM, Litvinov DN, Sevidov SM, Sporov AE (2017) Simulation of synchronization of nonlinear oscillators by the external field. East European Journal of Physics 4(1): 75-84.

9. Kuklin VM, Litvinov DN, Sporov VE (2018) Superradiance of stationary oscillators. Problem of Atomic Science and Technology 116(10): 217-220.

10. Kuklin VM (2019) On the Nature of Coherents in the System of Oscillators. Problems of Atomic Science and Technology 122(4): 91-95.

11. Kuklin VM, Litvinov DN, Sporov AE (2017) Superradiant emission regimes of the system of stationary oscillators. Problems of Atomic Science and Technology 6: 101-104.

12. Kuklin VM, Litvinov DN, Sporov AE (2017) Dissipative generation regime of a system of stationary oscillators. Problems of Atomic Science and Technology 6: 88-90.

13. Kuklin VM, Litvinov DN, Sporov VE (2018) The superradiance of bunch of rotating electrons. Problem of Atomic science and Technology 116(4): 221-224.

14. Kuklin VM, Poklonskiy EV (2021) Dissipative instabilities and superradiation regimes (classic models). Problem of Atomic science and Technology 134(4): 138-143.

15. Kuklin VM (2019) Energy exchange between the field and the active medium of the waveguide. East European Journal of Physics 6(3): 46-53.

16. Kuklin V, Lazurik VT, Poklonskiy EV (2021) Semiclassic Models of the Dissipative Regime of Instability and Superradiation of a Quantum Radiator System. East European Journal of Physics 2: 98-104.

17. Poklonskiy EV, Totkal SO (2022) Superradiation of mobile oscillator. East European Journal of Physics. 3: 14-18.