Review of: "Dynamics of Three-Level Laser Pumped by Electron Bombardment"

Babak Parvin

Potential competing interests: No potential competing interests to declare.

In this article, the behavior of N cascaded three-level atoms enclosed in a two-mode optical cavity in the degenerate and non-degenerate cases is examined theoretically. The atomic spontaneous emissions and cavity losses are considered in the calculations, and the atomic pumping is done by the electron bombardment. The language of the article is fluent, but the number of references in the article can be increased. The method of calculations and the results obtained for many atoms are interesting. At this stage, the author could apply the following recommendations to improve the quality of the article:

1- In the text of the article, the author mentioned these cases "open cavity" and "closed cavity", it is recommended that the difference between of these two cases should be more discussed in the text of the article.

2- The effect of the electron bombardment as a pumping process is indirectly included in the calculations. Why the pumping effect, i.e., r_a, is not considered in equations (30), (48) and (49) in the one-atom case?

3- How the mathematical formula for the atomic electron bombardment can be entered in the master equation (12), so that the calculations can be followed directly?

4- Considering that in the weak field limit, the ground level population is close to 1 for a single atom, why did the author mention this phrase "This result holds whether the atoms are initially in the top or bottom level."? (On page 7, after equation (84).)

5- Similar subjects to this work have been discussed in the following articles and theses, so it is recommended that the author should add the following works to the list of the article references:

R1- Tewodros Yirgashewa, Coherently Driven Three-Level Laser with Parametric Amplifier, Dissertation, Addis Ababa University, April 2010.

R2- Menisha Alemu, Three-Level Laser Coupled to Squeezed Vacuum Reservoir, Universal Journal of Electrical and Electronic Engineering 7, 187-200, 2020.

R3- Yosef Terefe, A Coherently Driven Degenarate Three-Level Atom, Thesis, Addis Ababa University, June 2013.

R4- Zeleke Behailu, Dynamics of Three-Level Laser Pumped by Electron Bombardment, Project, Addis Ababa University, March 2017.

R5- Solomon Getahun, Entanglement formulation in the framework of electrically pumped laser cavity, International Journal of Modern Physics B 30, 2016, 1650024.

R6- M Alemu, Effect of spontaneous emission on entanglement and squeezing properties of three-level laser pumped by electron bombardment, https://doi.org/10.1007/s12648-022-02457-2.

R7- Tamirat Abebe, Coherently Driven Nondegenerate Three-Level Laser with Noiseless Vacuum Reservoir, Bulg. J. Phys. 45, 2018, 357–373.

R8- B. Alemu, Ch. Gashu, E. Mosisa, T. Abebe, Dynamics of the Cavity Radiation of a Correlated Emission Laser Coupled to a Two-Mode Thermal Reservoir, Ukr. J. Phys. 66, 2021, 1027.

R9- Lamrot Hailu, The Squeezing Property of Coherently Driven Degenerate Three-Level Atom in a Closed Cavity, Quant. Phys. Lett. 10, 49-54, 2021.

R10- Samuel Mosisa, Tamirat Abebe, Milkessa Gebeyehu and Gelana Chibsa, Enhancement of Squeezing in a Coherently Driven Degenerate Three-Level Laser with a Closed Cavity, Global Journal of Science Frontier Research: A Physics and Space Science 19, 7, 2019.

R11- M. Molla Gessesse, The Noise Effect of Vacuum Reservoir on the Dynamics of Three-Level Laser Pumped by Coherent Light, Ukr. J. Phys. 65, 385, 2020.

R12- Fesseha Kassahun, Three-Level Laser Dynamics with the Atoms Pumped by Electron Bombardment, http://arxiv.org/abs/1105.1438v3.

R13- Tamirat Abebe, Chimdessa Gashu, and Nebiyu Gemechu, Coherently Driven N Number of Degenerate Three-Level Atoms with Parametric Amplifier, https://doi.org/10.1155/2020/7849035.

R14- Tamirat Abebe, Tewodros Yirgashewa, and Abebe Belay, Enhancing Steady-State Entanglement Generated by a Nondegenerate Three-Level Laser with Thermal Reservoir, https://doi.org/10.1155/2021/5550206.

R15- Fesseha Kassahun, Two-Level Laser Dynamics with a Noiseless Vacuum Reservoir, http://arxiv.org/abs/1209.4723v1.

R16- M. Molla Gessesse, Electrically Pumped Two-Mode Laser Dynamics, Ukr. J. Phys. 66, 2021, 206.

R17- M. Molla Gessesse, Interaction of Two-Level Atoms with a Single-Mode Quantized Radiation Field, Ukr. J. Phys. 66, 2021, 570.

6- On page 13, in the first paragraph, in the case of r_a=0, the author has mentioned this sentence "From Eqs. (157) and (162), we see that the two-mode cavity light is in a minimum uncertainty state.", in this instance, what kind of the light will be emitted from the system (in the viewpoint of photon statistics)?

7- According to the parameters used in the article, how the lasing conditions of this system can be expressed?