Title
Review of “Coherent Cherenkov radiation and laser oscillation in a photonic crystal”

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Abstract

The acronym laser stands for light amplification by the stimulated emission of radiation and in the article “Coherent Cherenkov radiation and laser oscillation in a photonic crystal,” it explains how lasers can be created by passing free electrons through a photonic crystal, instead of using pumping and population inversion.

1. Introduction

In order to create a laser, there needs to be population inversion. To achieve this, there needs to be pumping, usually by electric currents, in order to create a gain, which depends on the type of medium, for amplifying an optical wave. When there is population inversion, there are usually multiple energy levels. The photons get pumped to the higher levels and when they relax back down to the lower levels, they release a photon, which is the stimulated emission needed for the laser. However, in the article, lasing seems to occur via shooting an electron beam through a photonic crystal, as shown in Fig.1.

2. Discussion

It is very important to have population inversion for an optical gain in the system. The system can be different level systems and depending on how many levels there are, different conditions occur when it is pumped. For example, in a two level system, population inversion in the steady state cannot be achieved by pumping while in a three level system, it can be. A step above that would be a four level system, where it is more efficient than the three level system and does not have a minimum pumping requirement like the lower leveled systems.

In the photonic crystal method described in the article however, the stimulated emissions do not depend on the gain medium but rather on the photonic crystals themselves and the electrons that go through them. This can steadily generate powerful lasers without needing the population inversion and instead be more scaled via the photonic crystals.

3. Conclusion

In conclusion, there are different types of lasers that can be created, whether it is by pumping different gain mediums to achieve population inversion or by injecting free electrons into a photonic crystal.

4. Figures

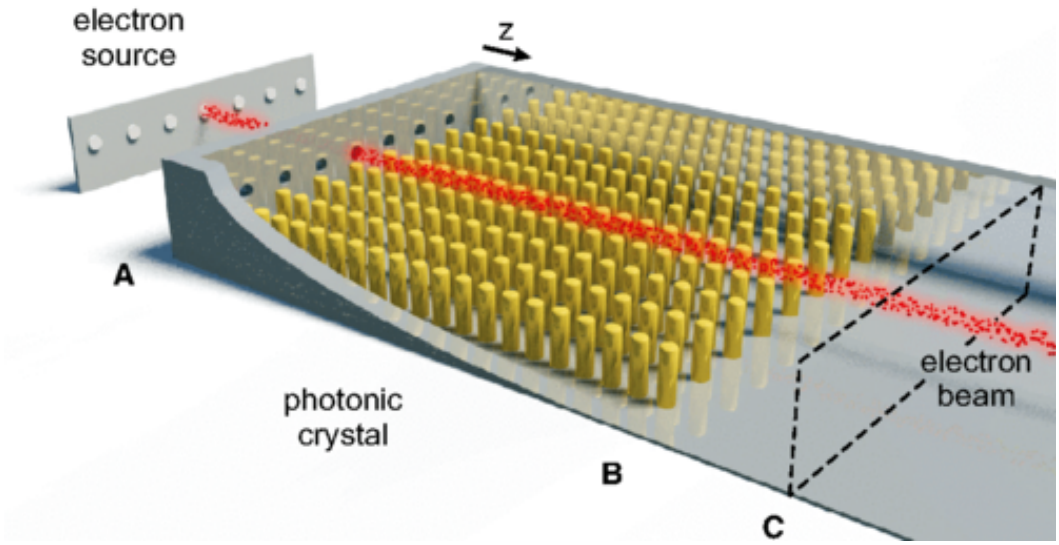

Fig. 1

Acknowledgements

T. Denis, M. W. van Dijk, J. H. H. Lee, R. van der Meer, A. Strooisma, P. J. M. van der Slot, W. L. Vos, and K.-J. Boller, “Coherent Cherenkov radiation and laser oscillation in a photonic crystal”, Phys. Rev. A 94, 053852, (2016).

Liu, Jia-Ming. *Principles of Photonics*. Cambridge University Press, 2017.