A thermodynamical treatment of a three level maser

Author: Andreas Evensen

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A beam of monochromatic light is where it all began; the fundamental field of maser/laser physics. Today it has developed into many branches, one being quantum optics: one treats the system from a quantum mechanical point of view. However, what is meant by the terms maser and/or laser? Commonly one refers to a system that emits monochromatic light, but this is a vague definition in itself; even candescent light-sources, such as an light-bulb, can be monochromatic if a frequency filter is applied. Thus a more suitable definition, still not adequate, would be that maser/laser have monochromatic and focused light. Even with this inadequate definition, we can see the importance of both masers and lasers in today's society: guiding missiles, cooling atoms, and even controlling your television. From a viewers standpoint them working is taken for granted, but how do they actually work? This question is answered in this report.

Light can be though of as a massless particle called a photon and depending on the energy contained it will have a specific wavelength. The human eyes are capable of observing wavelengths in the range of $380 \cdot 10^{-9}$ to $740 \cdot 10^{-9}$ meters. This is the reason that some laser-light can be observed whilst some may not. More than this, this limits the masers/lasers capability; a laser-pointer that you might have at home can not be used to cool down atoms. In this, one therefore construct a maser with its application in mind such that it can perform its intended task.

In this paper, a specific type of maser was investigated; the maser under investigation had features which relates to thermodynamics. In doing so, powerful tools were given: the upper boundary of the efficiency was already provided, and relevant information about the temperature in the system could also easily be calculated. Investigation on certain conditions were conducted, which majorly yielded expected results; however, some results were unexpected, which include oscillatory behavior in the system. The oscillatory behavior observed was a direct effect of the systems construction, which naturally gave a cyclic behavior for certain conditions.