Laser/Physical principle

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Physical principles of Laser Radiations

Laser equipment produces intense radiations of light that are highly collimated. In addition, the beams are monochromatic and coherent. It is these unique characteristics of the lasers that enhance their application in various fields of physics. Generation of lasers call for some unique physical conditions. These include: population inversion, element of feedback and presence of an active medium.

Population inversion refers to a state in which higher energy levels have more number of electrons than the lower energy levels. This is really contrary to quantum physics, but the condition has to be met for lasers to be generated. The idea of population inversion is necessary to ensure energy changes when electrons transits between energy levels. A population inversion may be achieved by a pumping scheme such as the three level or four level pumping scheme. According to Bertolotti, after population inversion has occurred, rapid decay occurs, since the inversion is a forbidden state of existence. It is from this decay, via the meta-stable state, that lasers are generated.

An active medium is another important element characteristic in generation of lasers. Active mediums are designed in a way to provide the platform for population inversion to occur. For instance, the structure of ammonium gas favors gas-state lasers. Also, aluminum oxide found in ruby is an example of desired state in solid state lasers. The element of feedback and resonance do occur in the laser generation cavity. During the pumping process, electrons are expected to collide and this generated the resonance (???). The fundamental resonance frequency where emission is pronounced is called the threshold frequency.

Simultaneous emission, unlike spontaneous emission, occurs when lasers are generated via pumping processes. The electrons are forced to higher energy levels as electromagnetic radiations impend(????). When the electron undergoes forbidden transition, it is expected to gain electromagnetic energy of the form hf (h is planck's constant and f is frequency). Upon losing this energy to the impending radiation(????), the electron falls back to its ground state. This energy is absorbed by the electromagnetic wave. The end result is that an amplified radiation, laser, results. This is stimulated emission of lasers.

Continuous and pulse mode lasers occur when power output of the lasers is varied. In continuous lasers, there is a constant output of power. This is mainly achieved by having a continuous pumping process. An example of this is in longitudinal mode lasers.

On the other hand, pulsed lasers have intermittent power output. The available power is divided over a time period and a rate determined for the emission. The result is a pulsed waveform. An example of this is in the Q-switching and the Mode locking lasers.

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