The Laser

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One of the causes of the progress of civilisation is the domain that the man has reached about the forces of natures. The civilisation, in its big jumps of progress, has passed of the domain from the fire to the machine of vapor; of the machine of vapor to the electricity, of the electricity to the atom; today we are trafficking the domain of the atom to the domain of light. This last great step it has accelerated in 1960, when in the Industrial Laboratories of the Society Hughes it was discovered a new y revolutionary generating device of light that produced a narrow luminous of extreme spectral purity. This device was baptized as LASER. The investigation, development and application of the LASER, has given to the civilisation a powerful instrument that is used for benefit of the society. The Medicine, the Biology, the Chemist, the Communications, the Agronomy, the Investigation and the Industry in General are some of the fields where the LASER has exceeded improved and overcome techniques, procedures and qualities that weren't achieved in previous times. From the invention of the LASER and the multiply applications that it gendered, the information about the LASER it has been restricted to journals and technical seminaries. The use of the computer has allowed to diversify the form of presentation of Scientifics works, using diverse means like images, videos, sounds, etc. that are known as multimedia. The objective of this work is to present a system multimedia that knows the principles, experiments and applications of the LASER. The system knows through images, videos and sounds each one of the characteristics y applications of the LASER in the different areas of the sciences and the technologies. The objective that pursues the system is to support the learning of the topics from the course of Modern Physics.

Key Words: Laser; Huges; light; spectral purity; multimedia; images, videos, sounds.

Theory

A laser is a radiation source in the visible, infrared or ultraviolet part of the electromagnetic spectrum and its name is an abbreviation formed with the initials: light amplification by stimulated emission of radiation, that is to say: amplification of light by means of the stimulated emission of radiation. To understand what means the previous sentence, better it is convenient to remember some concepts for this way to be able to compare to the laser with other conventional sources of light. All physical system, be solid, liquid or gassy, it is compound for atoms; each atom possesses a certain quantity of internal energy and it spreads to occupy a state in which this energy is minimum. To this state he/she is called state it bases. Also, an atom can be in some configuration with energy E_1, E_2, ..E_i, .En superior to that of the state bases; to these states they are denominated excited states. Einstein settled down in 1917 that an atom can absorb, if it is in its state it bases or to emit if it is in one of its excited states, a radiation whose frequency is $n_{ij} = (E_j - E_i)/h$ where $E_i < E_j$ and h are the constant of Planck. Because of this quantization of the radiation energy, it is said that an atom absorbs a photon of frequency Ej - Ei. The emission when passing the atom of the state E_j to the state $E_{i,}$ it can happen in two ways: spontaneously or induced by a photon. It is spontaneous when the atom without receiving radiation Ei decays to the state after an alienator period of life of the order of 10-8 seg. If one makes impact on the atoms radiation of frequency n_{ij}, the atoms in the state E_i can absorb a photon that elevates them to the state E.g. But in turn the atoms in the state E_j can be induced by a photon to originate another that is identical in frequency, energy, address and phase to which induced the emission. The original photon continues its trajectory and it is exactly the same one that before its interaction with the atom but now it is accompanied by another photon that is identical to him. These two photons in turn can impact on other atoms and to induce them to emit. One has this way an amplification of the number of photons that you/they travel in certain address. In a lamp

of tungsten filament, example of conventional source of light, the atoms that constitute the filament, rise continually for heating to excited states. Later on, the atoms decay spontaneously to the state it bases losing energy and emitting light; this happens to each atom independently of the other ones, that is to say, the disorder associated to the matter to high temperatures is reflected in the aerator emission of photons. In consequence, the emitted radiation is isotropic and it possesses a continuous spectrum of frequencies. The discharge tubes constitute another type of source of light that very well-known to be used in luminous signs of light of neon, and in the physics laboratories, as lamps of sodium, mercury, etc. to obtain monochrome light. These sources are, like he/she is proven easily, cold and they have a tube where is a gas (or mixture of gases) and two electrodes to those that are applied a high voltage that causes a discharge current that he/she goes accompanied by a luminous emission. When analyzing the spectrum of this emission, it is found that it is discreet, that is to say, formed by a series of lines taken place by the spontaneous emission of the atoms in excited levels. In this case, the intensity associated to a certain wave longitude, or ghastly concentration, it is bigger than in the previous source. One can make that these tubes emit in a narrow region of the spectrum, like in the lamps of mercury or sodium, for what is said that these sources are almost monochrome; the space distribution of the radiation is also isotropic. The ghastly concentration of these two sources presents, nevertheless, serious limitations, since even the laboratory lamps have a too big ghastly width for certain applications. This problem doesn't happen, for example, with the radio waves where the electromagnetic oscillator generates waves confined to a small region of the spectrum. The light of any conventional source calls herself incoherent light because it arises as a group of waves that you/they are reinforced or some are canceled at random to other: the wave front varies from instant to instant and of point to point. This light is incoherent so much space as storm. The space incoherence is due to that these sources are not punctual, but rather they have finite dimensions; this way, the light emitted at random by atoms that are moved away to each other until several centimeters, arrives to a point for different optic trajectories. On the contrary, the light spacely coherent, it arises of a point. The temporary incoherence refers to the impurity of the radiation, that is to say, to the poly chromatic of the light that arises of these sources; or, inversely, monochrome light is temporarily coherent light. Of the above-mentioned, you concludes that one can have temporary and spacey coherent light if it comes from a point and it is monochrome. Obviously this is achieved with a source of conventional light, placing faces him a small, punctual opening and before this a filter that selects a single frequency; but it is also obvious that when making this most of the light it is wasted, since the alone opening allows to pass a small part of the total of the light and the filter still weakens more it. For these reasons it is seen that even with a very intense source of light a sheaf of very weak coherent light is obtained.

For the exposed considerations one could think of modifying in some form a source that generates a quasi-monochrome radiation, as a discharge tube, so that the photons emitted by the means that constitutes the source, arise cohesively, that is to say, with certain specific characteristics and in certain instants, instead of making at random and in different instants. This is what happens in the laser, thanks to the emission induced with the one that a photon multiplies conserving all its phase characteristics, frequency, address and polarization. To achieve this it is necessary that the induced emission of photons is bigger than the absorption that he/she spreads to make them disappear and the theory shows that for it the number of atoms in the superior state should be bigger than in the inferior state. This requires of a mechanism of pumping that gives to the atoms selectively the necessary energy; this is achieved in the discharge tube I lower specific conditions of pressure, voltage, composition of the mixture of gases, etc.

If later it is placed to the means transformed into amplifier in a resonant cavity to a defaulted frequency, the result will be the appearance of an intense electromagnetic oscillation of the same frequency. The space characteristics and storms of this oscillation will be determined by the cavity that will make that all the photons are emitted in phase, being obtained coherent light, in contrast with the conventional sources. The coherent radiation confined in the cavity you can extract making that one of their ends is semi transparent to the radiation.

Therefore, the laser is an optic oscillator: a radiation source constituted basically by a half amplifier where this is generated and a resonant cavity that contains it. From their appearance, diverse types of lasers that emit from the distant infrared until the ultraviolet one have taken place.

Basically they are four the properties that characterize by the light of the laser and those that determine their exceptional importance in the modern optics and their enormous utility:
a). - Great intensity. The light of the laser can be very intense and it can concentrate on an object, with appropriate eyeglasses, heating it to high temperatures. The light of lasers like those of ruby or CO2 whose power is of the kilowatts order, it can perforate until diamonds. But the common lasers in the teaching like that of Helium-neon, they have a very low intensity and even when their light concentrated on the hand he/she would not even feel; however it is potentially harmful for the eyes if he/she looks at himself directly. Although the intensity of the sheaf of Have-Ne it is low, it is the sufficiently intense thing to make experiences in places that have delicate environmental light and to see them clearly.
b). - Great mono - chromatic. The light of the laser is almost monochrome that is to say that has a single color or wave longitude; this characteristic is also known as temporary coherence and he/she refers to that the emitted photons have the same frequency.
c). - Great space coherence. He/she refers to the fact that the sheaf leaves a point practically and the most intense part is in the center. This property is related with the temporary coherence and he/she takes advantage in the experiences where the undulatory character of the light is shown.
d). - Great collimation. The sheaf of the laser has a very small divergence that is to say that the width of the sheaf is almost constant along big distances, what allows to use it in experiences where it is needed an intense ray and collimated.

All these characteristics allow carrying out with easiness and extraordinary clarity, experiences and practical that has been traditionally very difficult of achieving.

Results and discussion

The figure shows the main window of the system that was elaborated as a result of the project. In her the name of the topic appears to try, the place where it was elaborated, the authors and finally two options: To leave and to Continue. If the user doesn't want to continue, alone he should make click in the button to leave to stop the program.

Figure 1

Otherwise, when making click in the button to Continue, the window that is shown in the figure 2 will appear. In her the options are shown: Principles, Applications and Experiments. These options treat the principles, applications and experiments related with the laser. He/she will be able to activate anyone of them with alone to make click in the corresponding option.

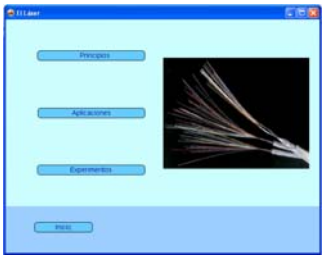

Figure 2

The figure 3 samples the following slide of the system, which corresponds to the topic of principles of the laser. In him it is explained, through audio and images, the basic principles with which the radiation laser is generated. When spreading, the audio corresponding with the image is activated. Of equal it forms, the options are shown: Beginning, to Repeat Audio, to Stop Audio and Following that the user will be able to activate in any moment. These options repeat or they stop the audio and the Following option passes to the following slide. Contrary to the first slide, another option that allows going back to the previous slide appears. This has the purpose that the user can move toward before or back freely through the system. Observe that in any slide he/she spreads the button beginning, which makes possible that the user returns to the beginning of the system without having the necessity to go back image for image.

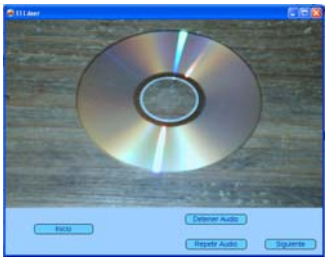

Figure 3

Objectives

- To develop a system multimedia that illustrates, through audio and images, the principles, applications and experiments with the laser.
- To show topics related with the modern physics.
- To support the educational work.

Conclusions

The System:

- It approaches topics related with the modern physics.
- It shows the physical principles with those that the radiation laser is generated.
- It illustrates some applications of the laser in the medicine, the communications, the agronomy, the investigation, the technique, etc.
- It presents experiments carried out with the laser, which are impossible or difficult of making with another radiation type.

- It can be consulted the times that it is wanted. With it is more probable to understand the fundamental ideas of the analyzed topics.
- It supports the educational work.

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