Laser Diffraction From Single Slit

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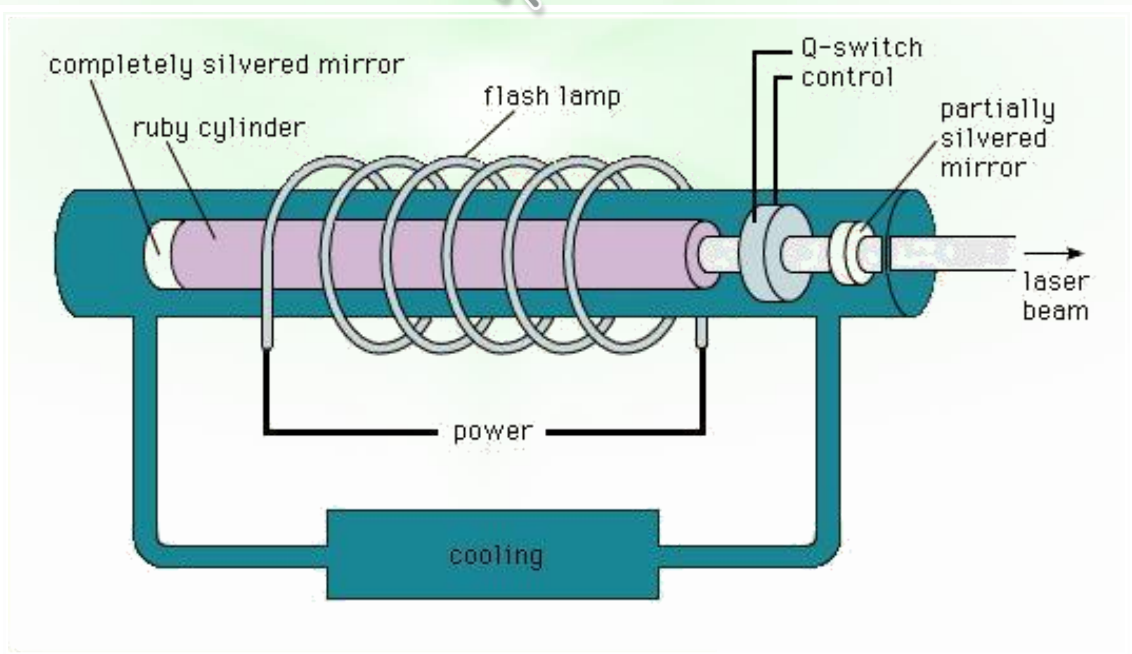
The word (**LASER**) is an acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation. **Laser** light today cover a wide range of wavelengths from about **150nm** to about **12000nm**, which includes the visible range of electromagnetic spectrum. The invention of **laser** source was possible ever since **Einstein** in **1917** showed theoretically that the process of stimulated emission of radiation must exist to balance the absorption and spontaneous emission of radiation processes.

In **1950** a group of **scientists** at **Columbia University** operated a microwave device that amplified radiation by stimulated emission process. This device was termed (**MASER**), an acronym for **M**icrowave **A**mplification by **S**timulated **E**mission of **R**adiation. In **1960**, **T.H. Maiman** produced a laser beam from Ruby crystal. Ruby is an aluminum oxide crystal in which some of the aluminum atoms have been replaced with chromium atoms.



For a **ruby laser**, a crystal of ruby is formed into a cylinder. A fully reflecting mirror is placed on one end and a partially reflecting mirror on the other. A high-intensity lamp is spiraled around the ruby cylinder to provide a flash of white light that triggers the laser action. The green and blue wavelengths in the flash excite electrons in the chromium atoms to a higher energy level. Upon returning to their normal state, the electrons emit their characteristic ruby-red light. The mirrors reflect some of this light back and forth inside the ruby crystal, stimulating other excited chromium atoms to produce more red light, until the light pulse builds up to high power and drains the energy stored in the crystal.

Basic Principles of Laser Operation

For the construction of laser system **three** basic requirements, which should satisfy certain conditions, must be provided, these are: -

1. An active medium: -

It represents the collection of atoms, molecules or ions that emit radiation in the optical part of the electromagnetic spectrum. The active medium of a **laser** might be in gas, liquid or solid form also a semiconductor.

2. Pumping energy: -

The energy needed for the excitation procedure in the **laser** medium.

3. Optical resonator: -

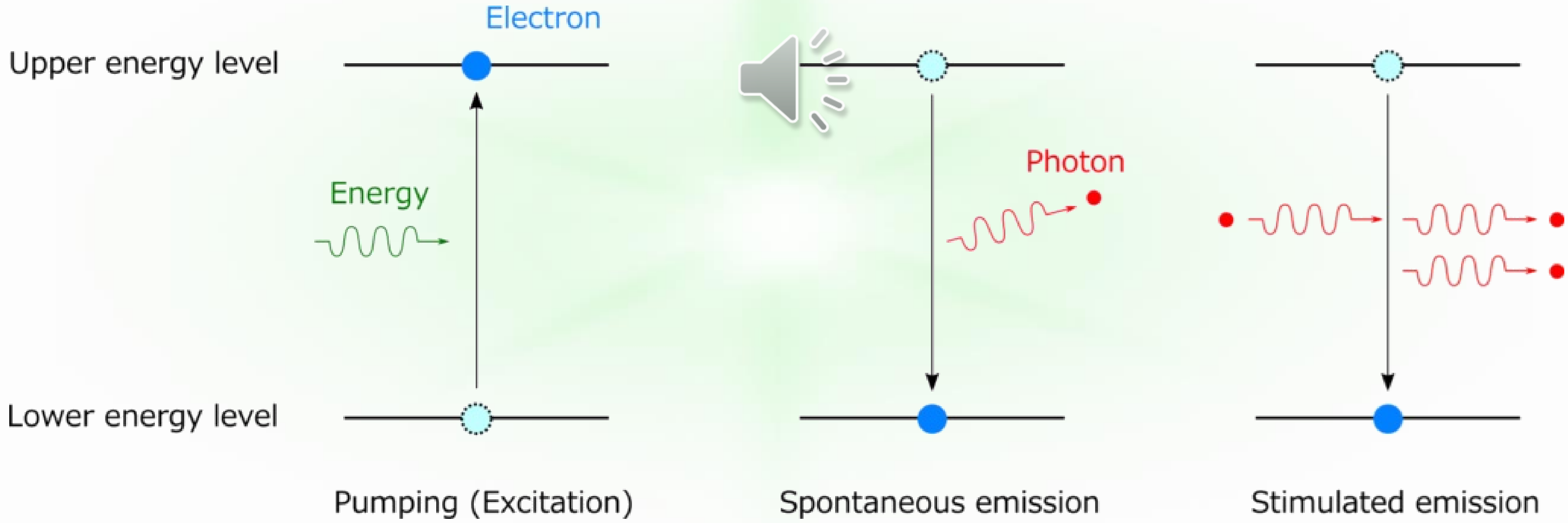
The means of the optical feedback in the **laser** system. This is needed for **laser** oscillations to provide a highly collimated monochromatic beam that makes the stimulated emission in the **laser** medium so useful.

Spontaneous Emission

An excited atom cannot continue having the excess of energy, which it had absorbed, for a long time. Usually it tends to return (**decays**) to a lower energy state by releasing energy, this process occurs **spontaneously** and **randomly**.

Stimulated Emission

The excited atom is forced by the incident wave to release photons in the same direction and frequency of incident energy. Radiation emitted by stimulated emission process is **coherent** and **directional**.



Laser Light Properties

Laser light differs from any other source of light. It represents the highest quality light source so far. The particular properties that are responsible for this high quality product are: -

1. Monochromaticity: -

The electromagnetic radiation is single frequency (**single-wave length**) or single color, a hundred percent Monochromatic radiation.

2. Coherence: -

This property is closely related to light wave nature, i.e., the **amplitude** and the **phase**. have approximately the same values of frequency and wavelengths.

3. Directionality: -

The most distinguished property of **laser** light is its directionality. The emission of this source is confined in a collimated, almost parallel beam of very small divergence.

4. Brightness: -

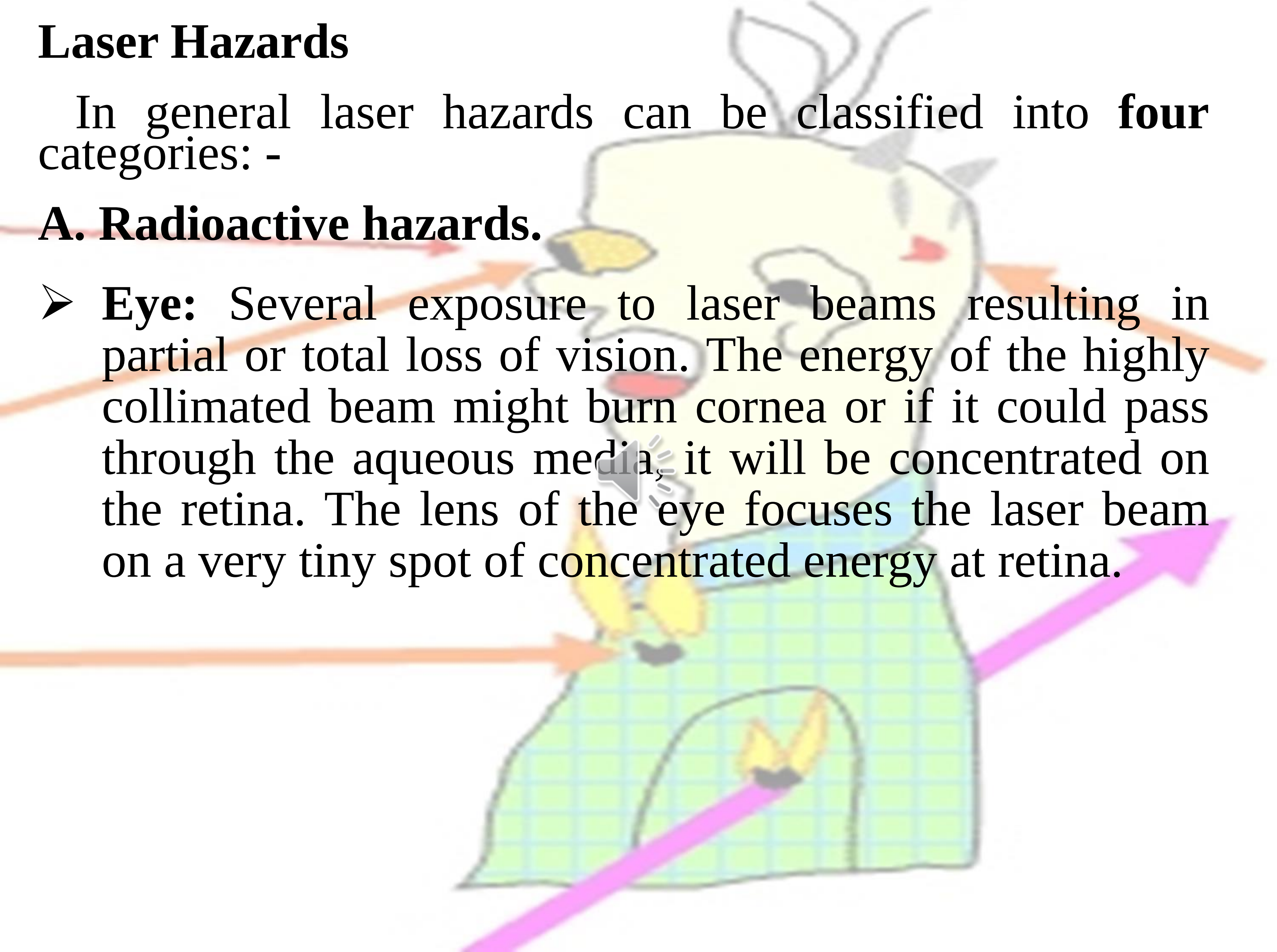
Laser is a bright light source and has high light intensity. Brightness is a quantity that depends not only on the total power emitted by the light source but also on its collimation.

Laser Hazards

In general laser hazards can be classified into **four** categories: -

A. Radioactive hazards.

- **Eye:** Several exposure to laser beams resulting in partial or total loss of vision. The energy of the highly collimated beam might burn cornea or if it could pass through the aqueous media, it will be concentrated on the retina. The lens of the eye focuses the laser beam on a very tiny spot of concentrated energy at retina.



- **Skin**

The skin is much less sensitive to laser radiation than the eye. The amount of reflected, absorbed and transmitted radiation depends on the laser wavelength and the pigment on the tissue. Exposed to high power radiation causes **reddening** in the skin and may be cause **damage** to the organ beneath the skin.

B. Toxic hazards.

Toxic hazard result from rapid **heating** and **vaporization** of targets as they exposed to high power laser beams.

C. Electrical hazards.

The input power for the laser systems is electrical and high voltage power supplies are required and sometimes involve large capacitor.

Electrical hazards involve shocks (**depend on the current flowing through the body**), this depend on the skin condition (**moist-dry**). The physiological effects of current flow in the body vary from mild sensation to painful for low currents and to muscular paralysis for high currents.

D. Explosive hazards.

Explosions occur in flash-lamps and capacitors e.g. (**the flash-lamps used to solid state lasers**).

Laser Categories

The majority of lasers in use today fall in **four** categories these are: -

i- **Solid-State Laser**, which includes (**Nd-YAG laser, and Ruby laser**).

ii- **Gas Laser**, which includes (**He-Ne laser, Argon ion laser, and Co_2 laser**).

iii- **Liquid Laser**, which include (**The dye laser**).

iv- **Semiconductor Laser**.

The Medical Applications of Laser

1. **Nd-YAG** lasers an excellent tool for tissue coagulation, so it use in the treatment of hemorrhagia (**uncontrolled bleeding from uterus**). It is also used in ophthalmology (**for eye diagnosis and treatment**).

2. **Ar^+** laser is used in the treatment of **diabetic retinopathy** it generated heat to photocoagulate the retina. It is also used in dermatology and plastic surgery.

3. **CO_2** laser is used in cutting and coagulation. It is also used in neurosurgery, plastic surgery and ophthalmology.

4. **Dye** Laser is used for cancer tumor detection and treatment. It is also used to fragment gall-stones and kidney stones.

5. **Laser** reduced the blood loss during surgery "**bloodless knife**".

6. **Laser** reduced oedema and postoperative pain.

7. **Laser** used for skin beauty and teeth whitening.

8. **Laser** caries detection aid.

9. **Laser** used for special three dimensional images called **holography**.

Thank You