LASER

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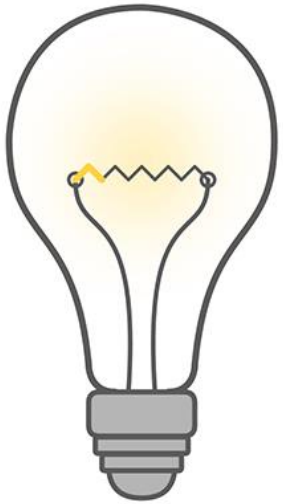
Introduction of LASER

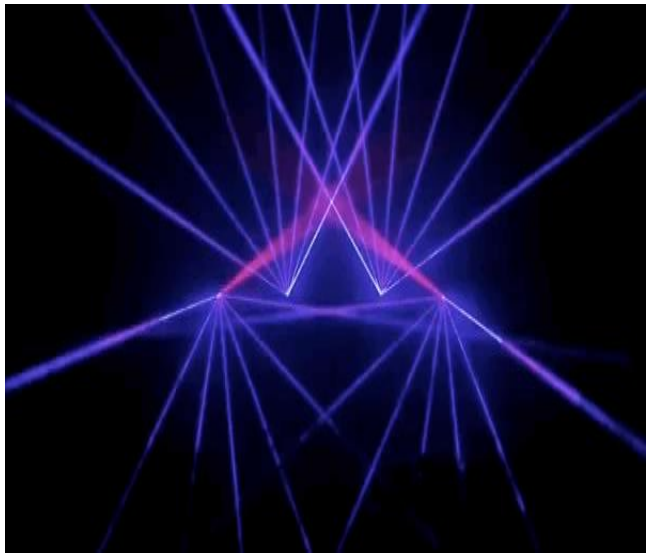
Light **A**mplification by **S**timulated

Emission of **R**adiation

Ordinary vs. Laser Light



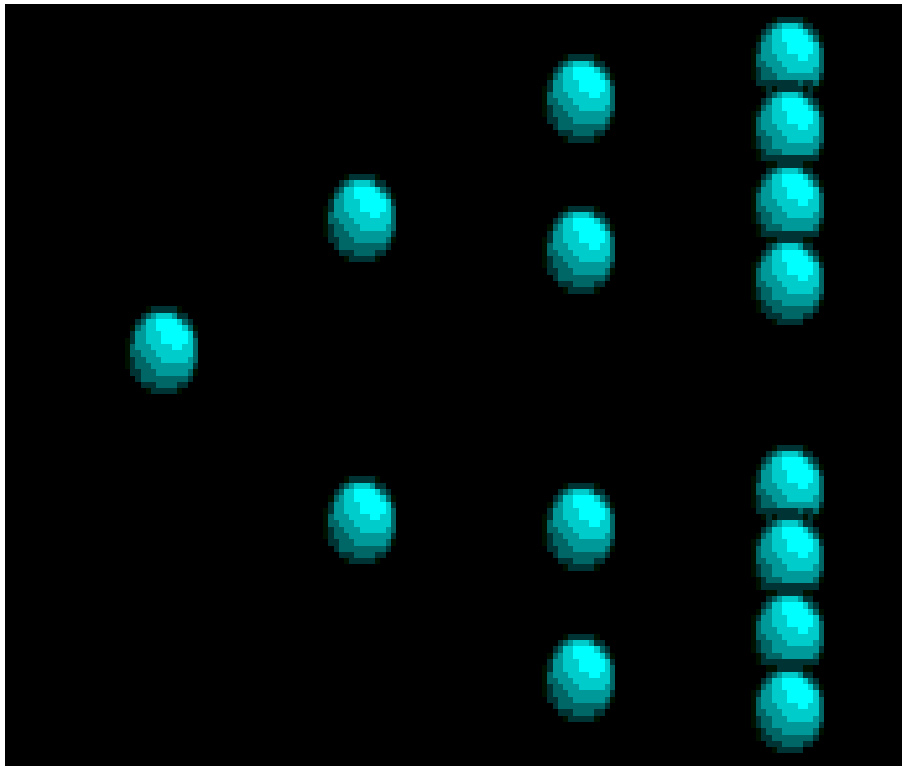
1. Many wavelengths
2. Multidirectional
3. Incoherent



1. Monochromatic
2. Directional
3. Coherent

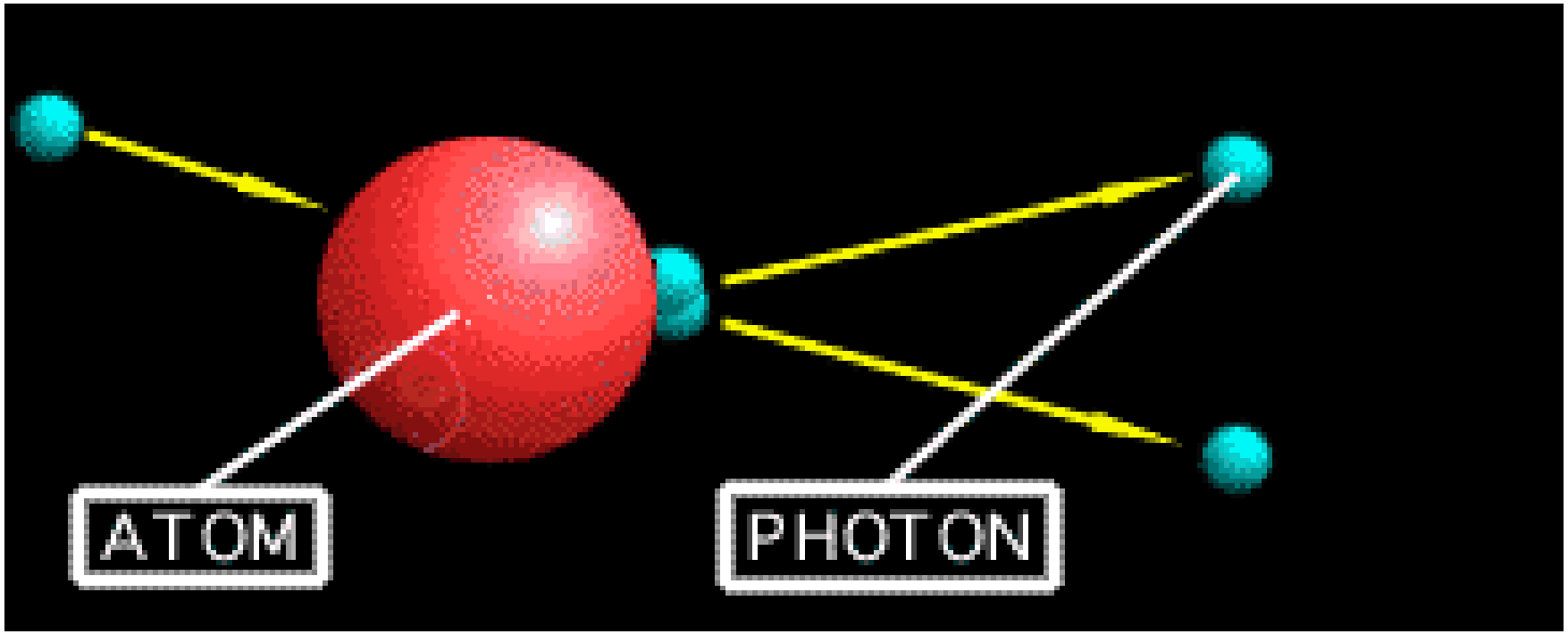
‘A’ stands for AMPLIFICATION

The laser may be activated by a few photons, but then many, many more are generated. The initial light is ***amplified*** to make a very bright compact beam.

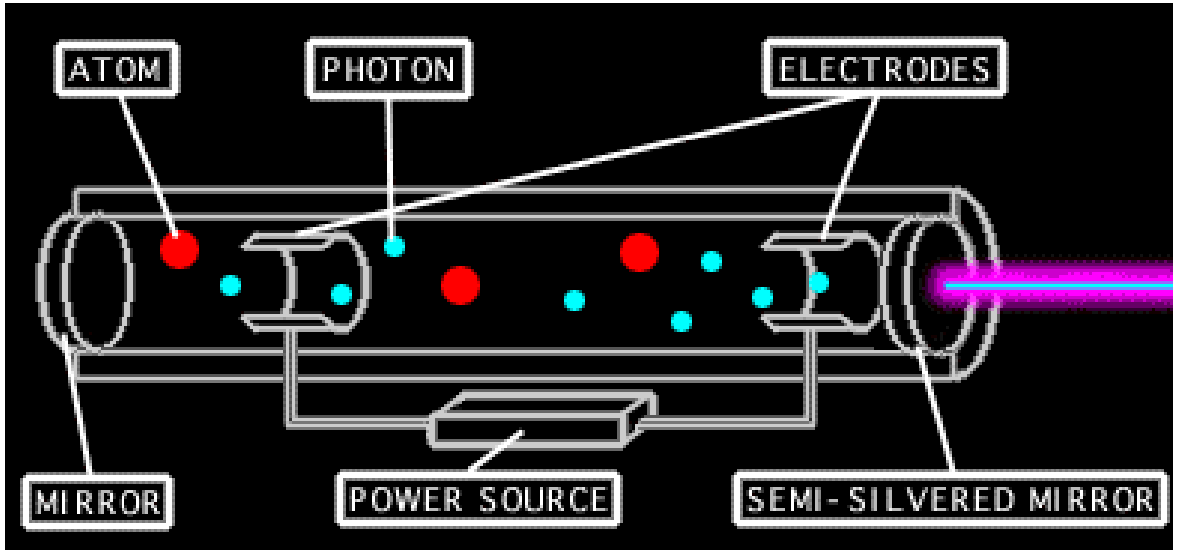


‘S’ stands for STIMULATED

- the photons are amplified by stimulating an atom to release more photons.



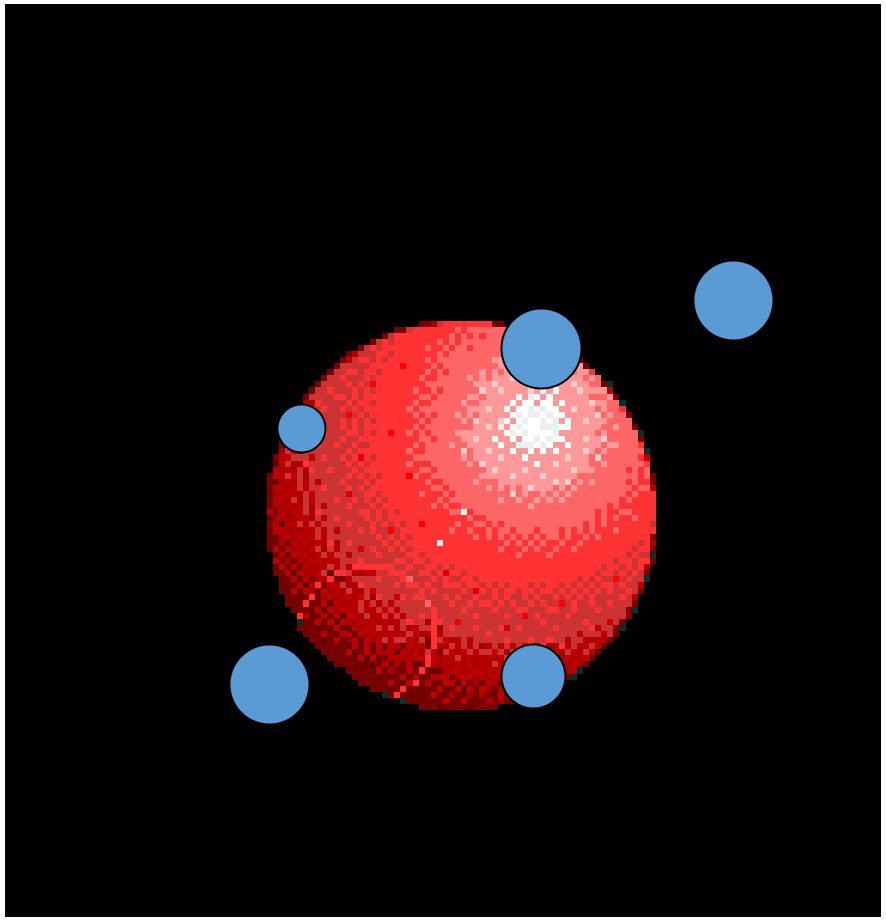
‘E’ stands for EMISSION



- The excited atom ***emits*** a photon when another photon comes by
- The photons bounce between the two mirrors until enough photons have been emitted that some pass through the semi-silvered mirror on one end. These are the photons which are seen as the laser beam.

‘R’ stands for RADIATION

- Radiation refers to the photons which are being emitted.



GENERAL OBSERVATION ABOUT LASERS

- They produce narrow beams of intense light
- They often have pure colors
- They are dangerous to eyes

PROPERTIES OF LASER

- ***Monochromatic***

  Concentrate in a narrow range of wavelengths (one specific colour).

- ***Coherent***

  All the emitted photons bear a constant phase relationship with each other in both time and phase

- ***Directional***

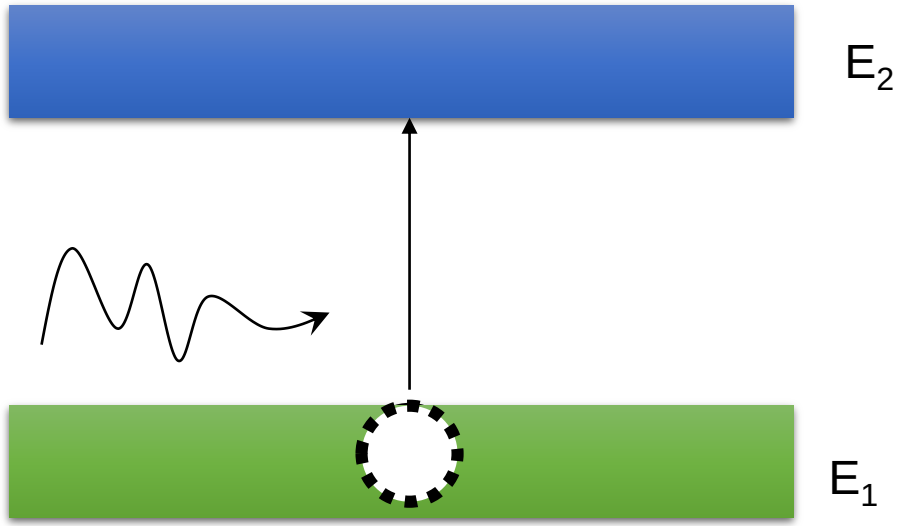
  A very tight beam which is very strong and concentrated.

Basic Concepts of A Laser

BASIC CONCEPTS OF A LASER

- ***Absorption***
- ***Spontaneous emission***
- ***Stimulated emission***
- ***Population inversion***

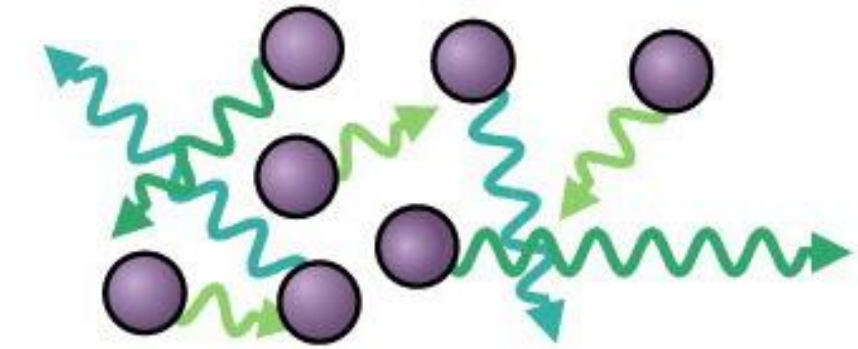
ABSORPTION



- Energy is absorbed by an atom, the electrons are excited into higher energy state.

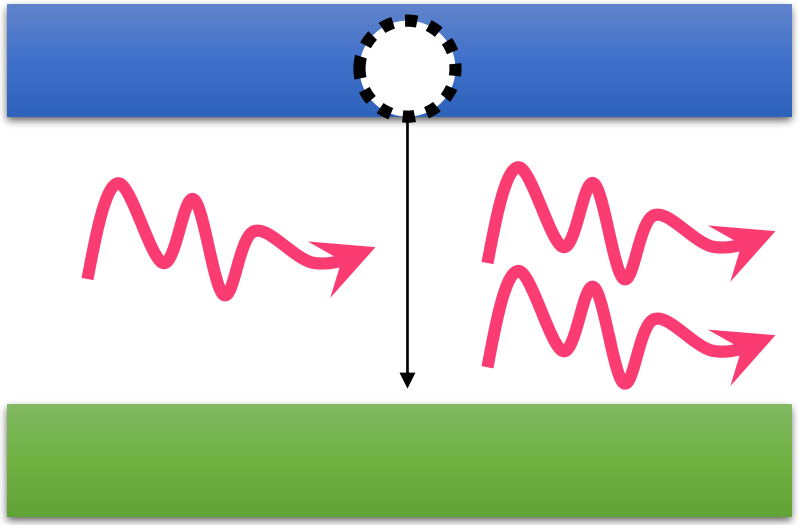
SPONTANEOUS EMISSION

- Excited atoms normally emit light spontaneously
- Photons are uncorrelated and independent
- Incoherent light



Incoherent radiation from excited atoms

STIMULATED EMISSION



- Atoms in an upper energy level can be triggered or stimulated in phase by an incoming photon of a specific energy.

The ***stimulated photons*** have unique properties:

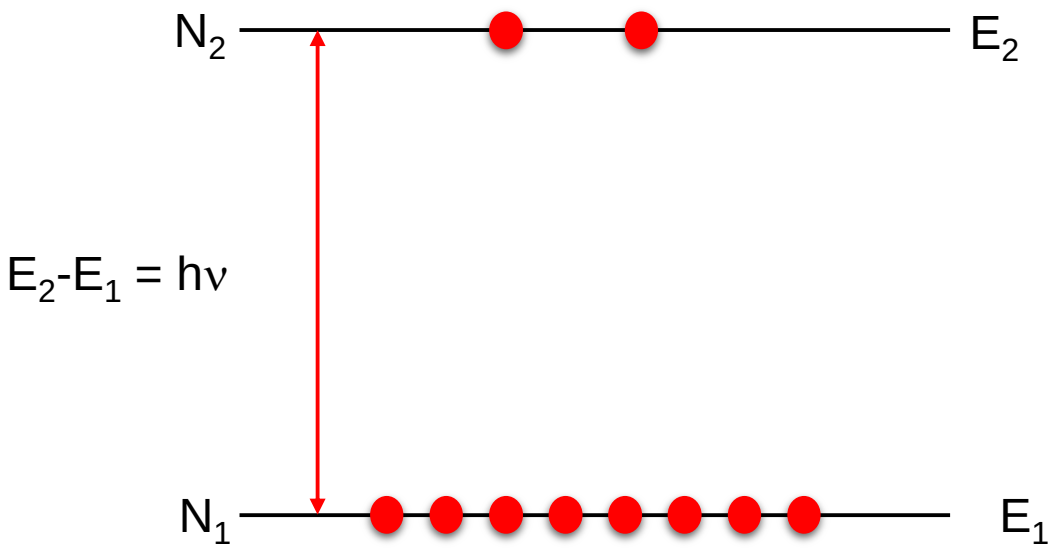
- ***In phase*** with the incident photon
- ***Same wavelength*** as the incident photon
- Travel in ***same direction*** as incident photon

POPULATION INVERSION

- A state in which a substance has been energized, or excited to specific energy levels.
- More atoms or molecules are in a higher excited state.
- The process of producing a population inversion is called ***pumping***.
- Examples:
  - by lamps of appropriate intensity
  - by electrical discharge

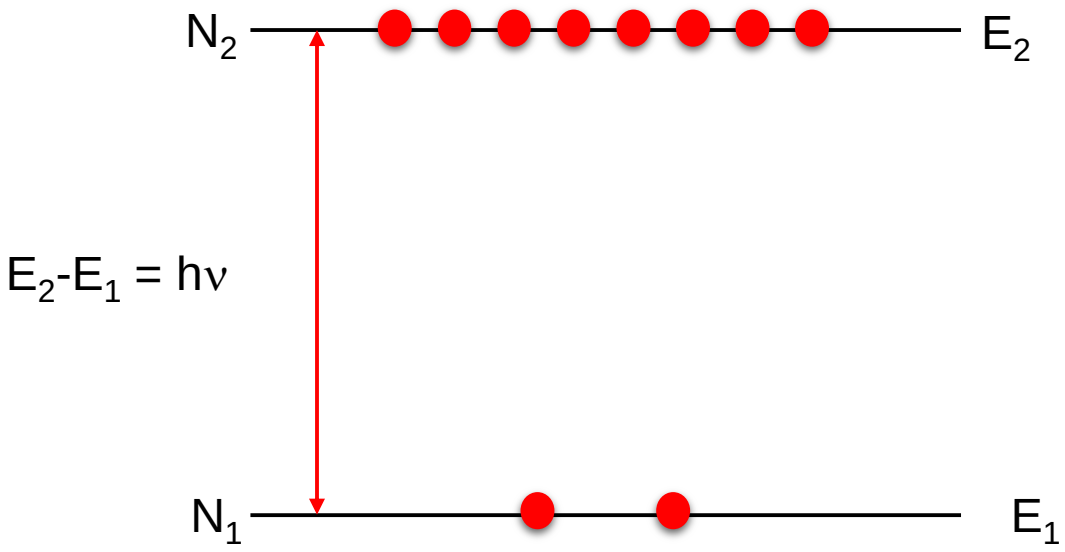
Population Inversion

In thermodynamically equilibrium



$N_1 > N_2$

● -electron



$N_2 > N_1$

Required for LASER Action

Common Components of All Lasers

COMMON COMPONENTS OF ALL LASERS

1. Active Medium / Gain Medium

The active medium may be solid crystals such as ruby, liquid dyes, gases like CO_2 or Helium/Neon, or semiconductors such as GaAs. Active mediums contain atoms whose electrons may be excited to a metastable energy level by an energy source.

2. Pumping (Excitation Mechanism)

Excitation mechanisms pump energy into the active medium by one or more of three basic methods; optical, electrical or chemical.

Resonance cavity

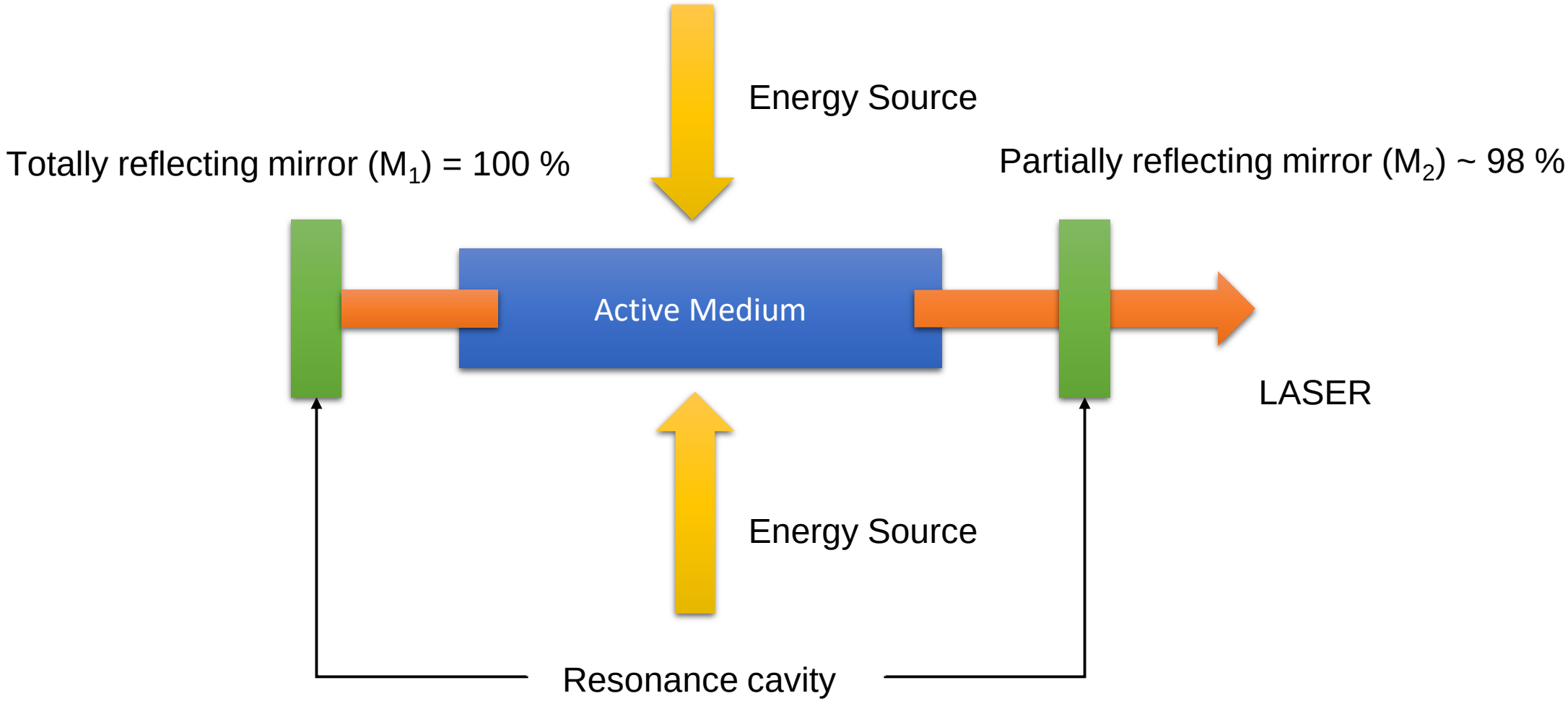
3. High Reflectance Mirror

A mirror which reflects essentially 100% of the laser light.

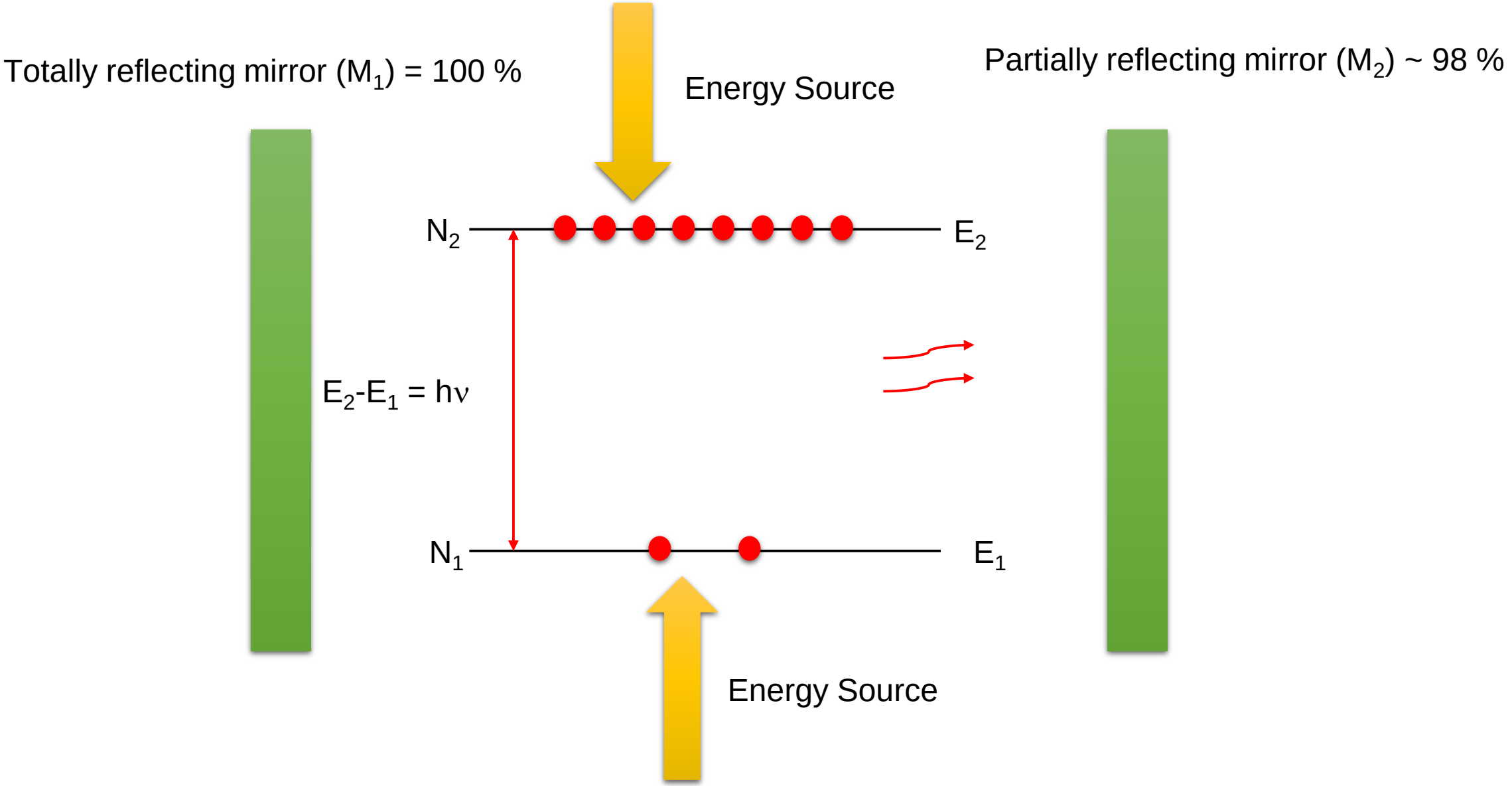
4. Partially Transmissive Mirror

A mirror which reflects less than 100% of the laser light and transmits the remainder.

BLOCK DIAGRAM OF LASER SYSTEM



Optical resonator



Applications of A LASER

- -Spectroscopy

-Lunar laser ranging

- -Photochemistry

-Laser cooling

- -Nuclear fusion

-Death ray

-Defensive applications

-Strategic defense initiative

-Laser sight

-Illuminator

-Rangefinder

-Target designator

INDUSTRY AND COMMERCIAL

-Cutting, welding, marking

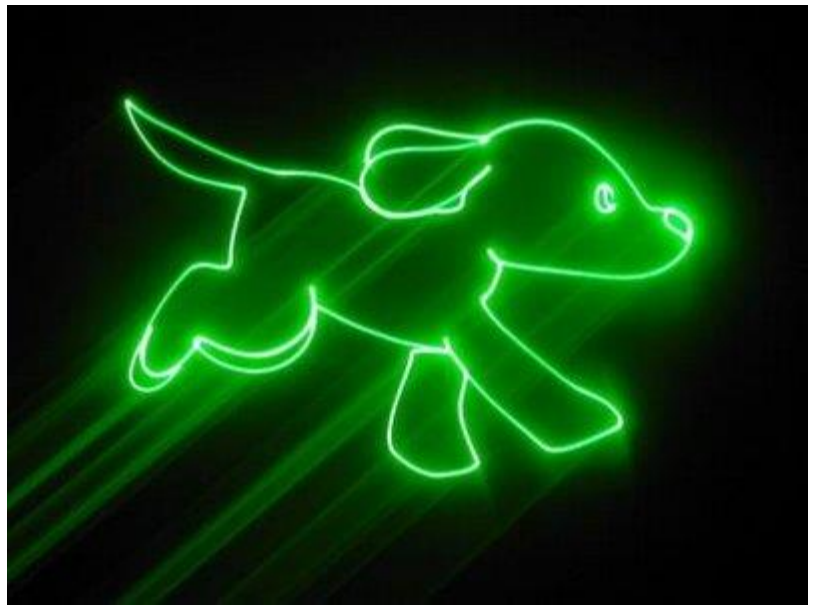
-CD player, DVD player

-Laser printers, laser pointers

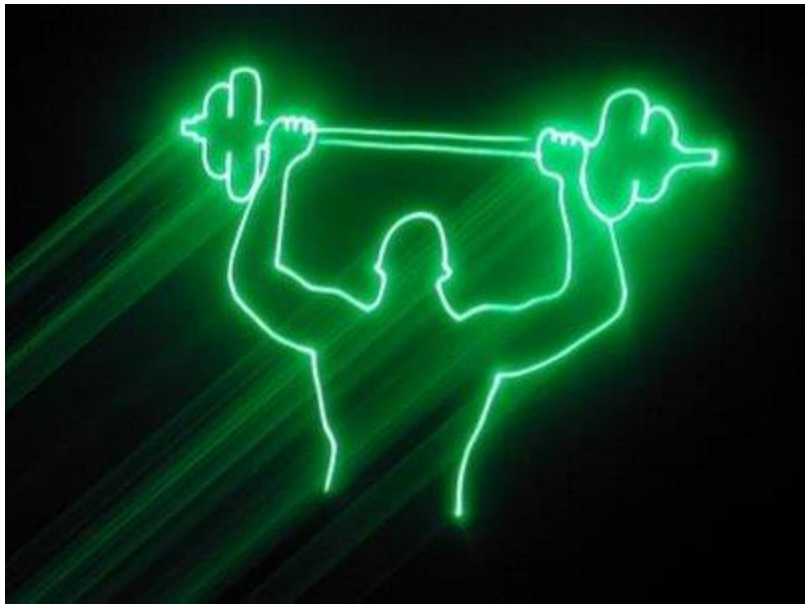
-Photolithography

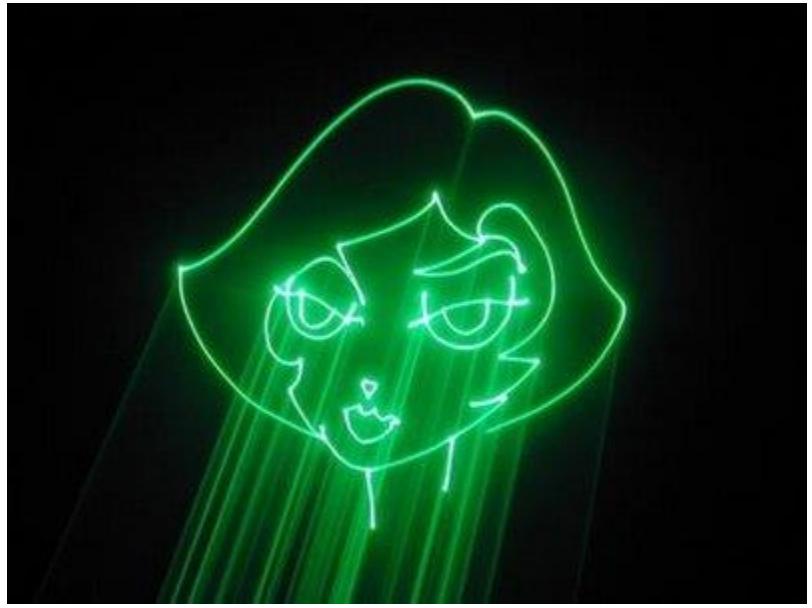
-Laser light display

Laser shows are quite popular and the special effects are amazing. These use lasers that are in the visible spectrum along with vibrating mirrors to paint images in the air.



- Another example of laser entertainment is the use of laser signs at trade shows





LASER SAFETY MEASURES

Types of Laser Hazards

1. ***Eye*** : Acute exposure of the eye to lasers of certain wavelengths and power can cause corneal or retinal burns (or both). Chronic exposure to excessive levels may cause corneal or lenticular opacities (cataracts) or retinal injury.

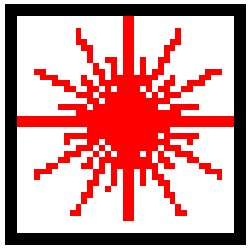
2. ***Skin :*** Acute exposure to high levels of optical radiation may cause skin burns; while carcinogenesis may occur for ultraviolet wavelengths (290-320 nm).

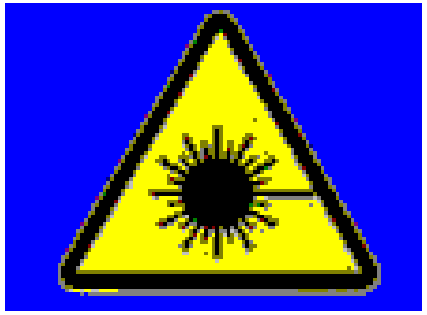
3. ***Chemical :*** Some lasers require hazardous or toxic substances to operate (i.e., chemical dye, Excimer lasers).

4. ***Electrical :*** Most lasers utilize high voltages that can be lethal.

5. ***Fire :*** The solvents used in dye lasers are flammable. High voltage pulse or flash lamps may cause ignition. Flammable materials may be ignited by direct beams or specular reflections from high power continuous wave (CW) infrared lasers.

Common Laser Signs and Labels





Technologies

- CATHODE RAY TUBE (CRT)
- VACUUM FLOURECENT DISPLAY (VFD)
- FIELD EMISSION DISPLAY (FED)
- LIQUID CRYSTAL DISPLAY (LCD)
- PLASMA DISPLAY PANEL (PDP)
- ELECTROLUMINISCENT DISPLAY (EL)
- ORGANIC LIGHT EMITTING DIODE (OLED)

CRT

- 100 YEAR OLD WORKHORSE
- CATHODOLUMINISCENT
- BEAM SCAN DEVICE
- LARGE VIEWING ANGLE
- HIGH BRIGHTNESS
- HIGH RESOLUTION
- GOOD COLOUR GAMUT
- BEST PERFORMANCE TO COST
- BULKY HEAVY
- UNIMPLEMENTABLE IN LARGE SIZES
- OBSOLESCENCE
- STILL ENJOYS 70% MARKET

THANK YOU