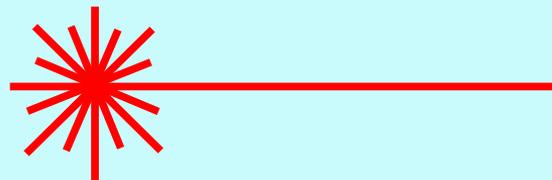


LASERS

Dr Gohar Taqi Kazimi

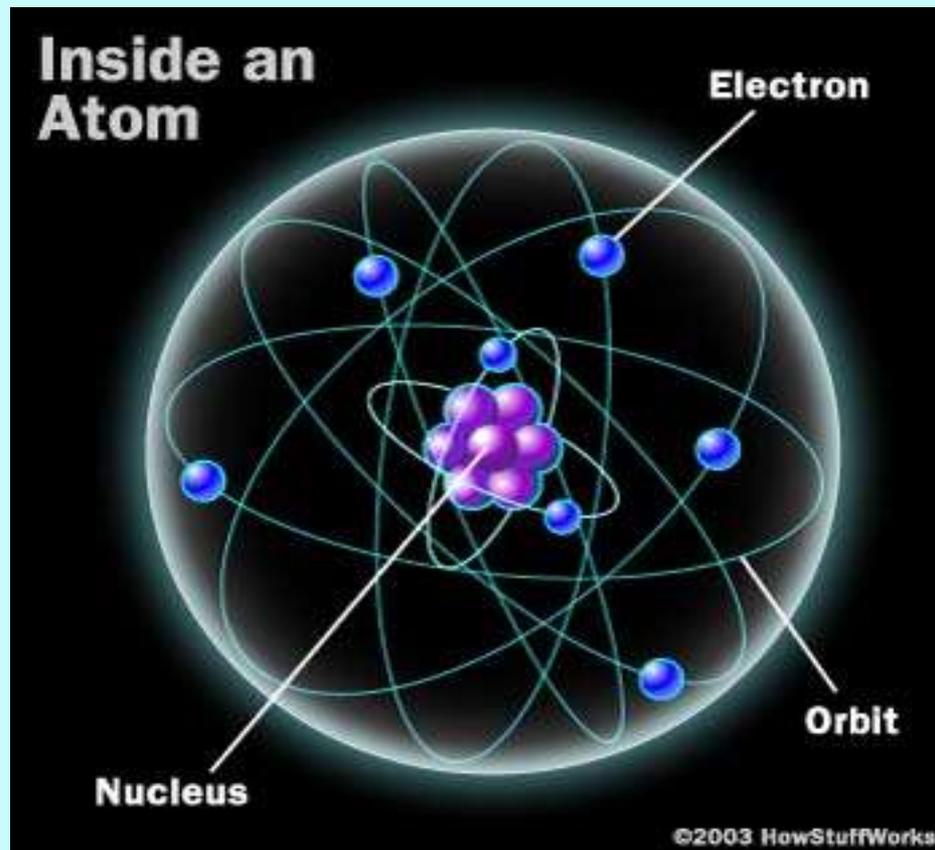
Assistant Professor
Department of chemistry



LASER

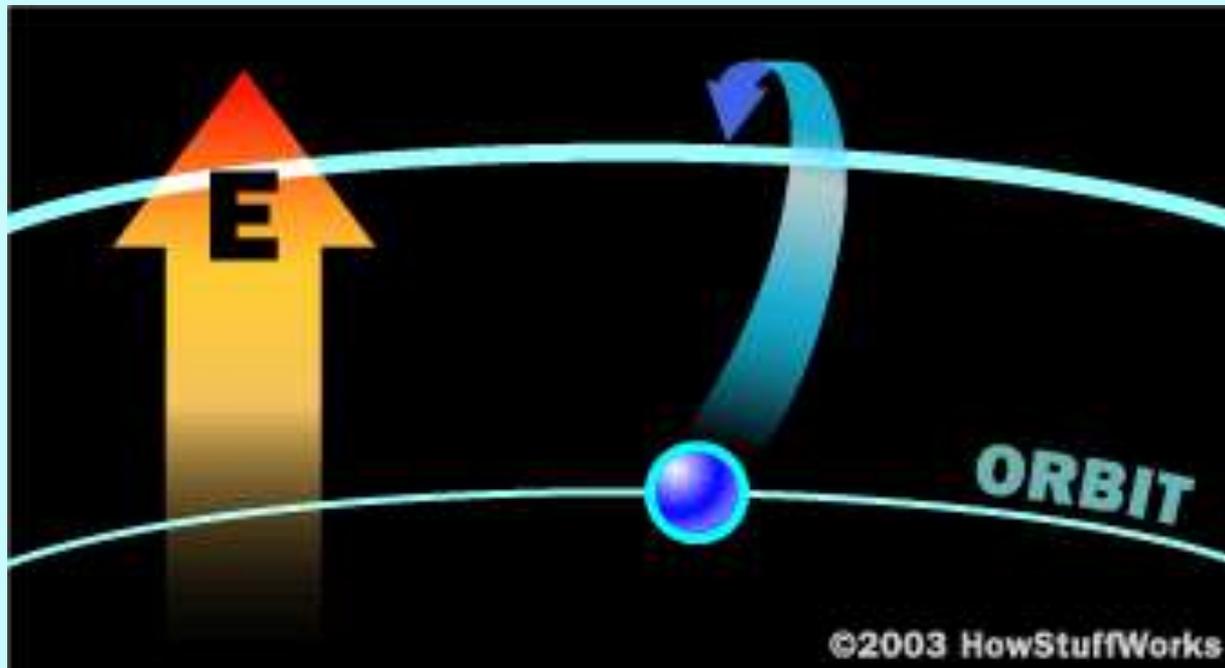
- LASER stands for Light Amplification by the Stimulated Emission of Radiation.
- Now laser is a word used to identify this type of equipment or the light it produces.
- A laser is an unusual light source. It is quite different from a light bulb or a flash light. Lasers produce a very narrow beam of light. This type of light is useful for lots of technologies and instruments (even some that you might use at home)

An atom consist of protons, neutrons present in nucleus and electrons revolving around the nucleus in different orbits having different energy levels.



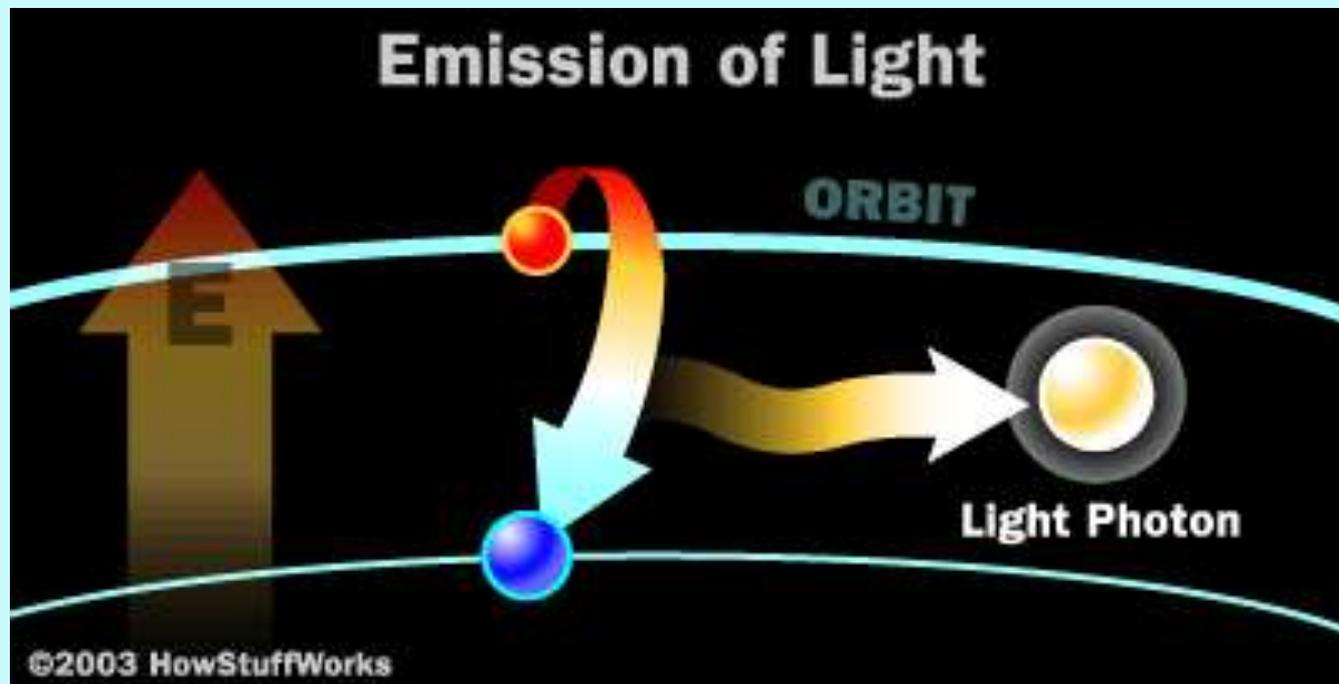
The Electron

Electron jump from low energy orbit to a higher orbit upon absorption of energy.



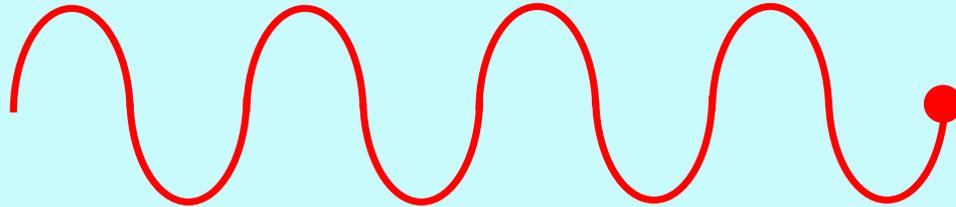
The Photon

When the electron drops back to its original orbit it releases energy in the form of photon. Light is made up of photons.



Wavelength of Light

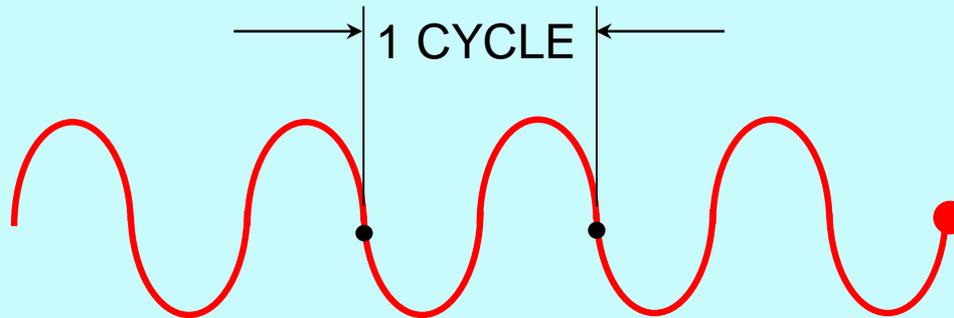
Light moves in waves that are similar to ripples in water.



Light is an example of **electromagnetic** radiation: It doesn't require a **medium** to pass through.

Each color of light has a different wavelength. For example, blue light has a shorter wavelength than red light. Sunlight—and the typical light from a lightbulb—is made up of light with many different wavelengths. Our eyes see this mixture of wavelengths as white light.

Wavelength of Light

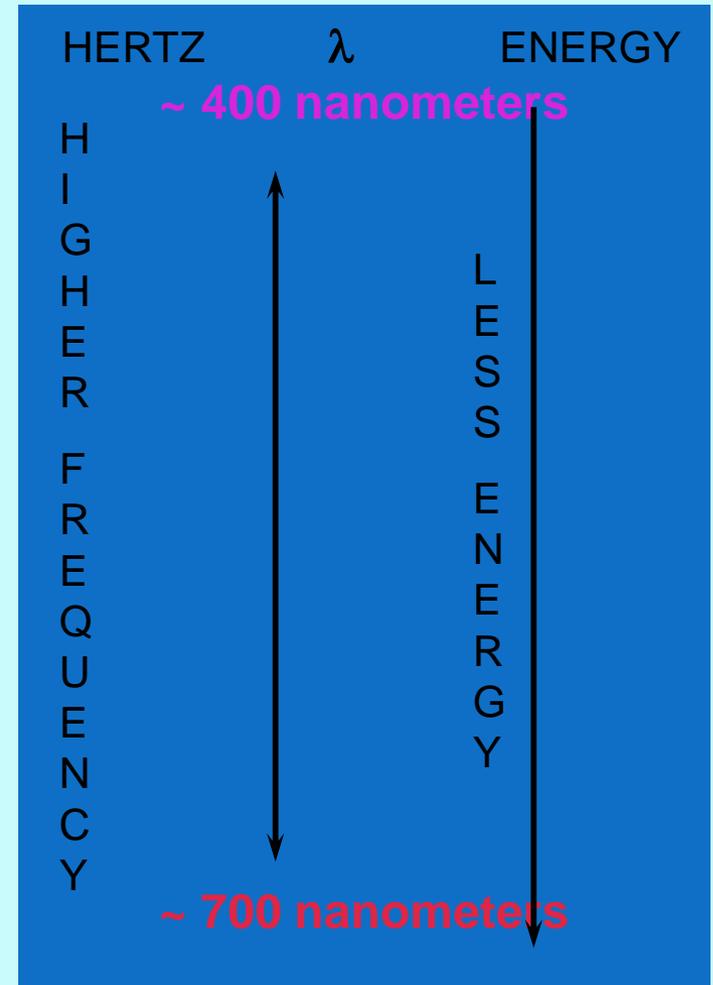
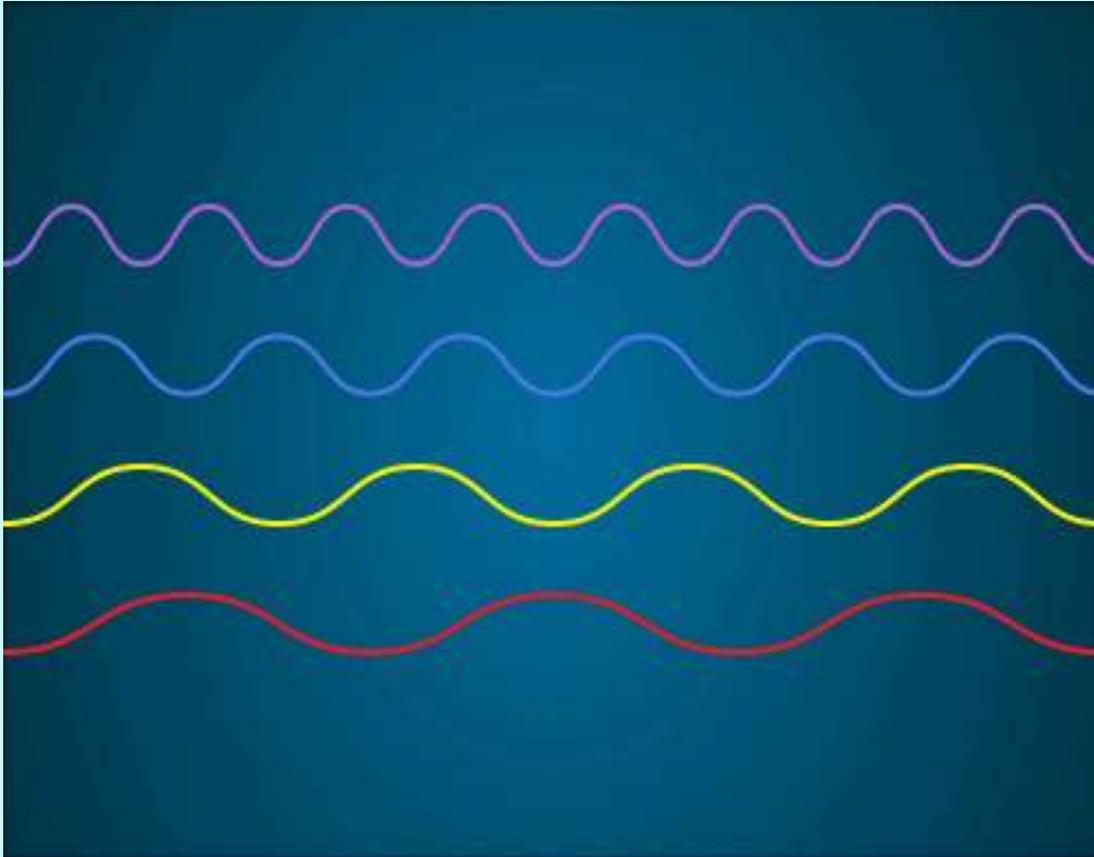


Wavelength (λ): The distance the wave travels in one cycle.

Frequency (f): The number of times a cycle repeats in one second (Hertz, formerly cycles/second).

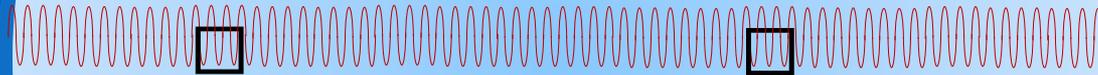
$$\lambda = \frac{c}{f}$$

Wavelength of Light



1 NANOMETER IS ONE BILLIONTH OF A METER

A human hair is about 80,000 nanometers in diameter.



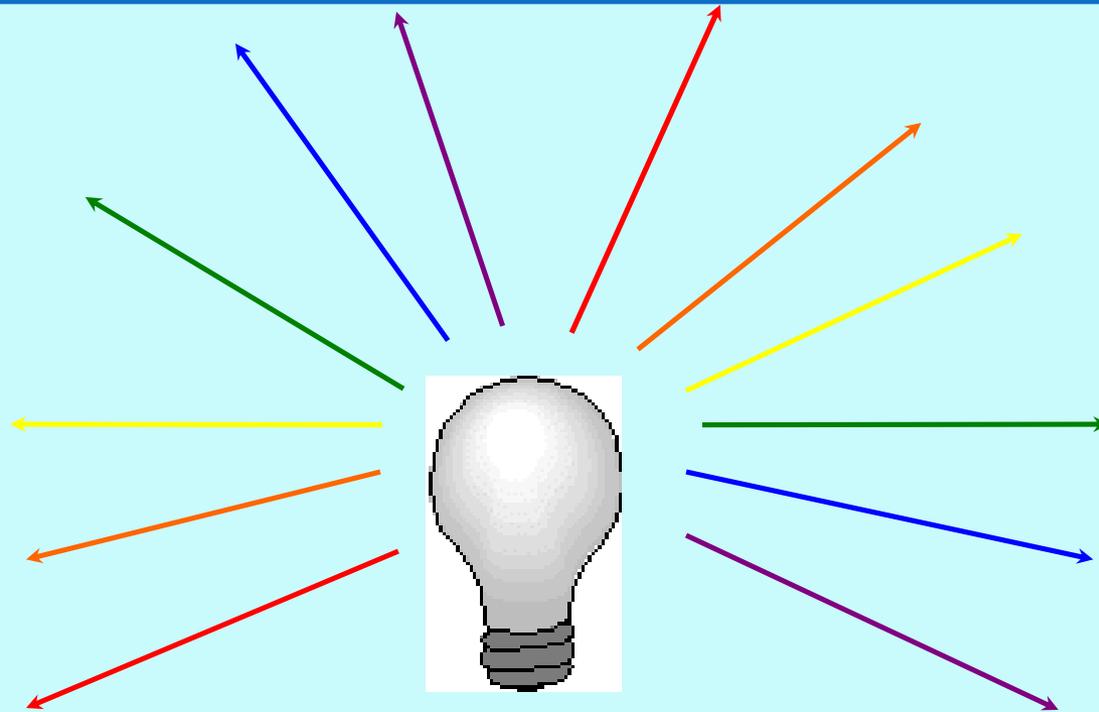
That's about 115 times the wavelength (λ) of red light.

Light Bulb

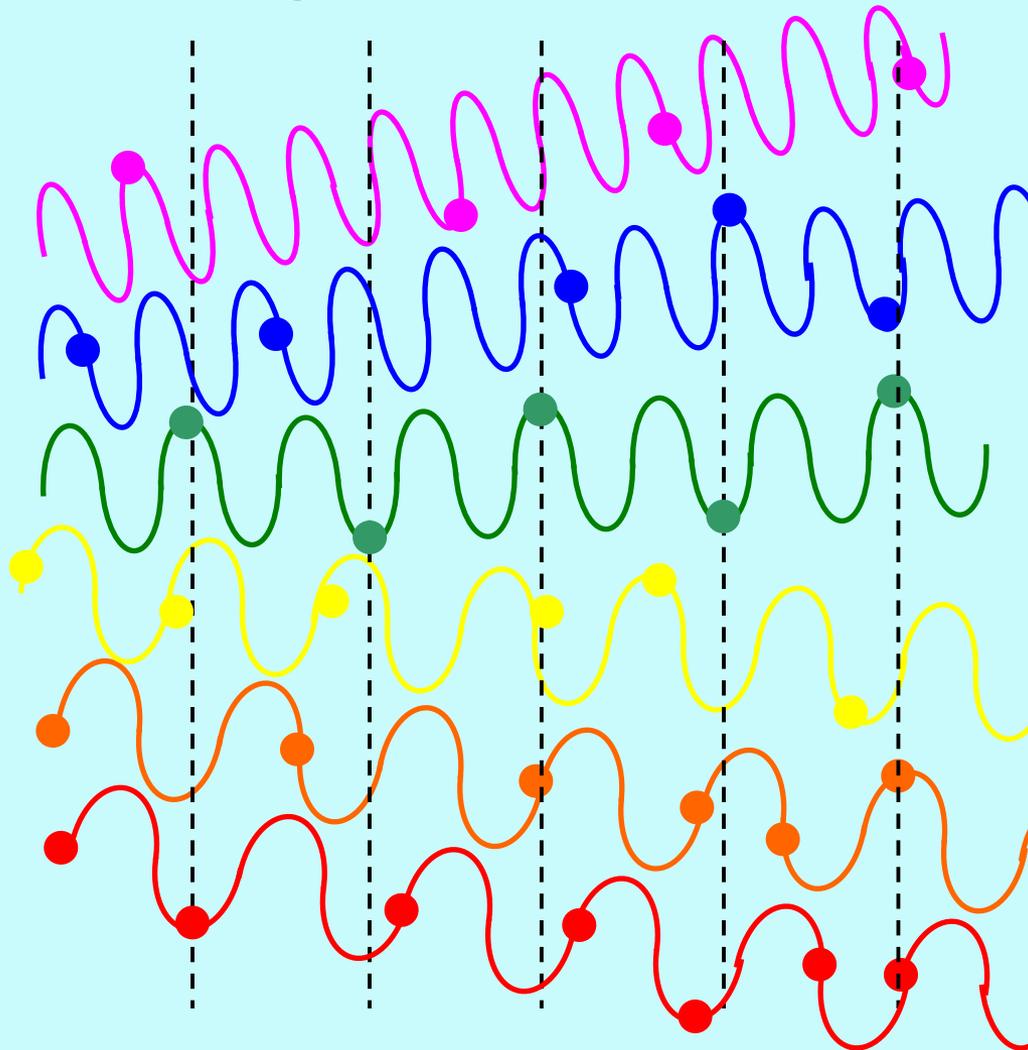
Light is not focused

Light is made up of many colors (wavelengths)

Light is not coherent



White Light

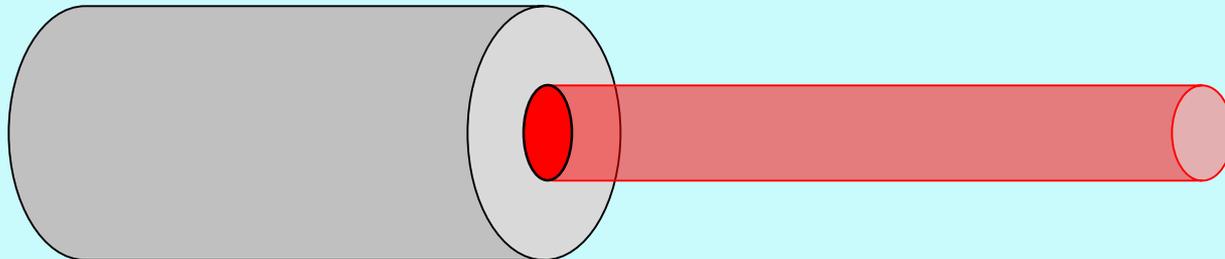


Light From A Light Bulb

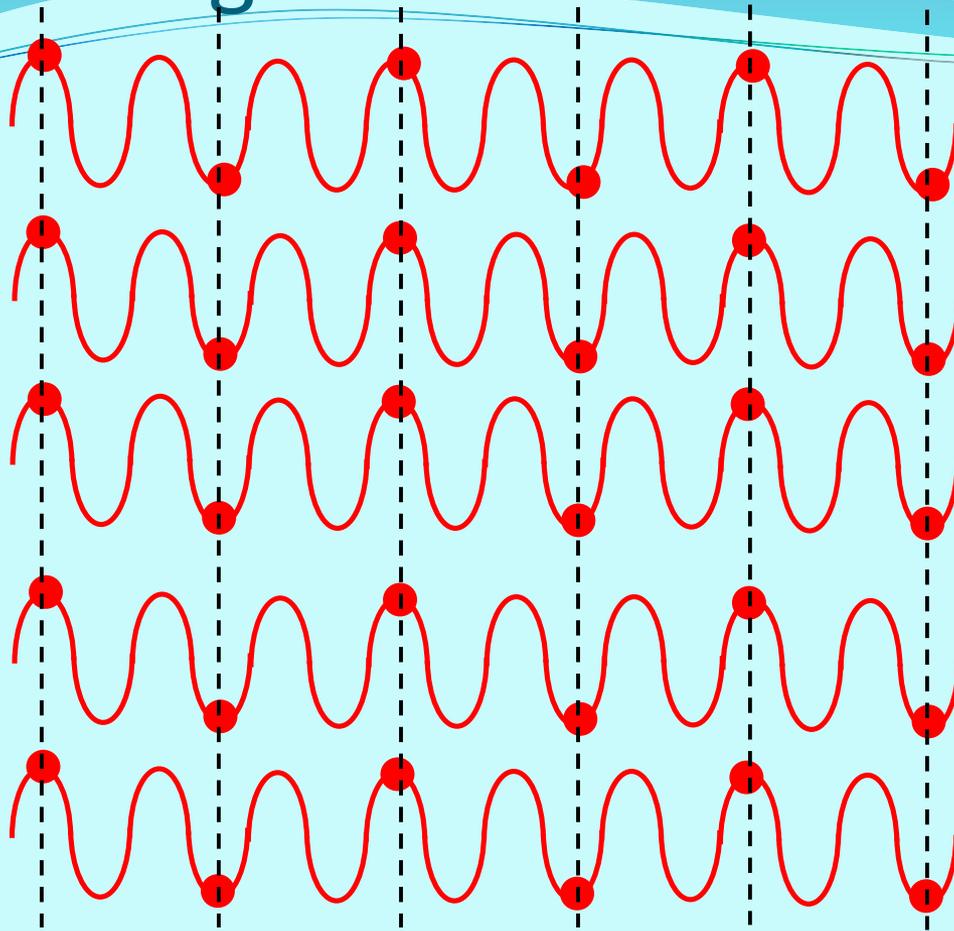
- All colors (wavelengths).
- More longer wavelengths.
- Light is not coherent.
- Light is not focused.

Laser Light

A laser is different. Lasers do not occur in nature. However, we have figured ways to artificially create this special type of light. Lasers produce a narrow beam of light in which all of the light waves have very similar wavelengths. The laser's light waves travel together with their peaks all lined up, or **in phase**. This is why laser beams are very narrow, very bright, and can be focused into a very tiny spot.



Laser Light



Light From A Laser

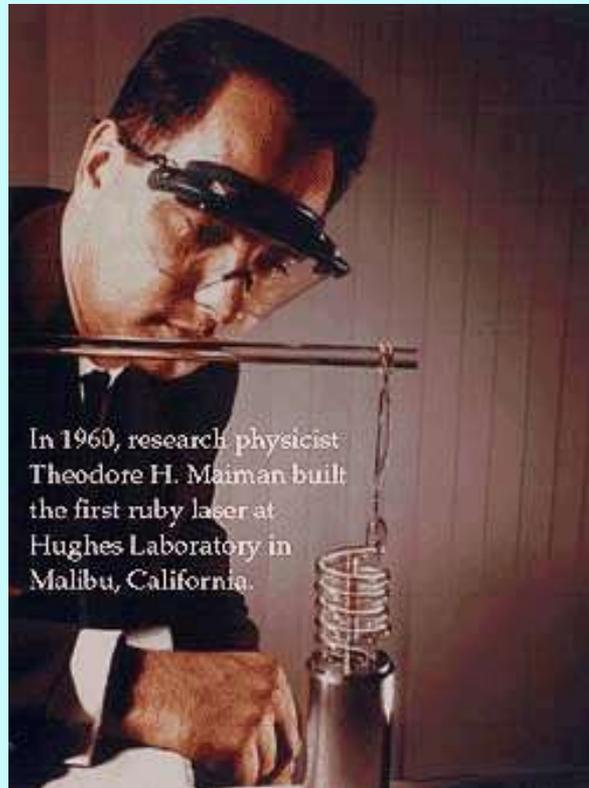
- One color (wavelength).
- Light is coherent.
- Light is focused.

Because laser light stays focused and does not spread out much (like a flashlight would), laser beams can travel very long distances. They can also concentrate a lot of energy on a very small area.

Theodore Maiman

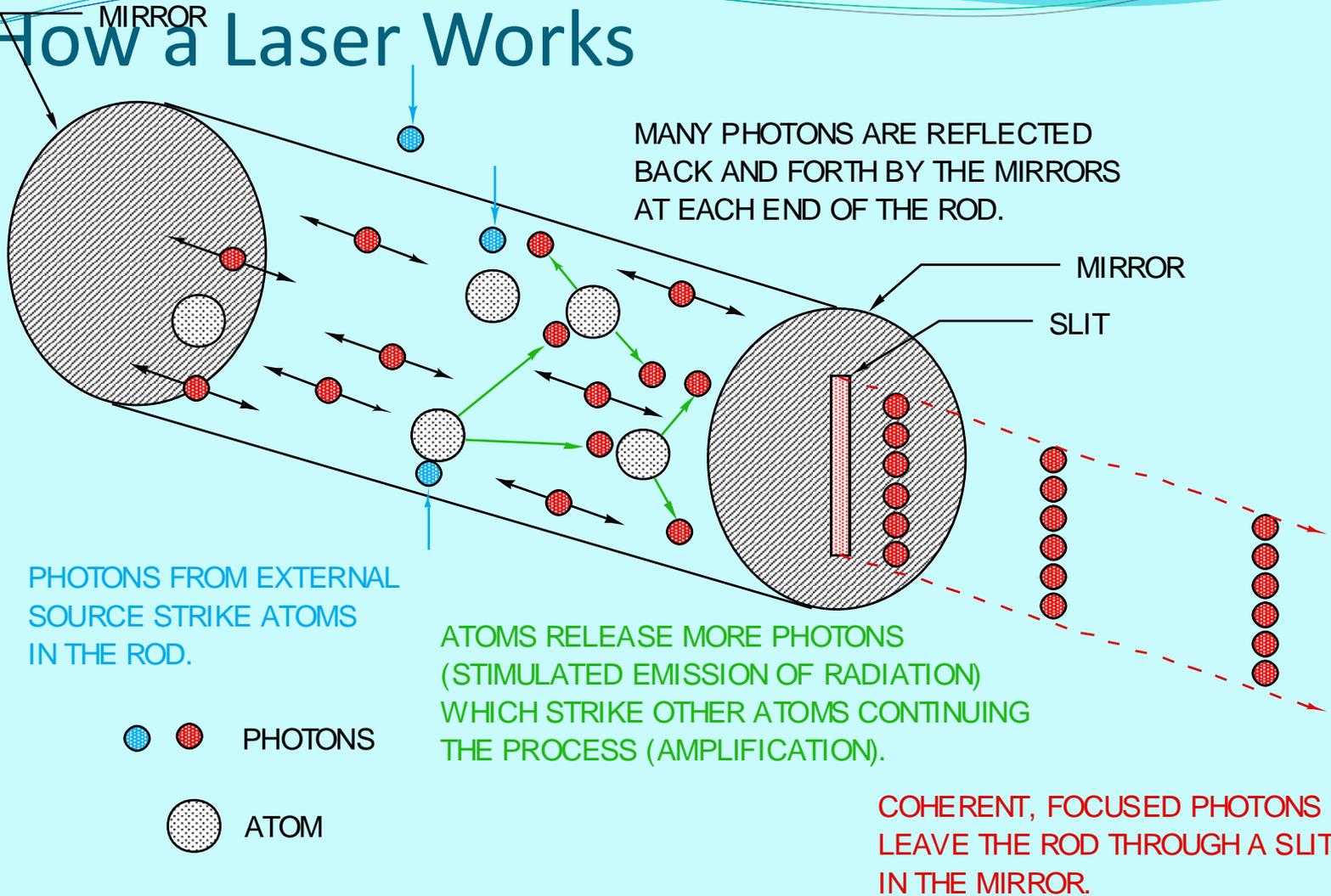
First Ruby Laser

1960



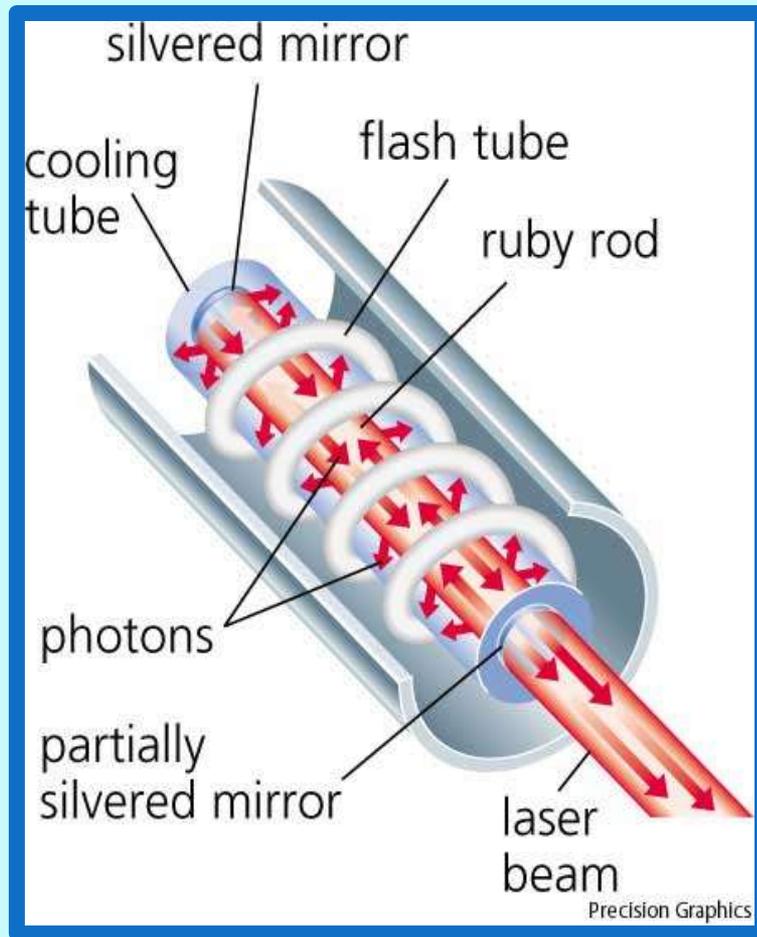
In 1960, research physicist Theodore H. Maiman built the first ruby laser at Hughes Laboratory in Malibu, California.

How a Laser Works



LIGHT AMPLIFICATION BY THE STIMULATED EMISSION OF RADIATION

Ruby Laser



Types of Lasers

Based on the material used in the Laser.
Based on the biological damage the
Laser can cause

Typical Lasers and Their Emission Wavelengths

<u>Laser Type</u>	<u>Wavelength (nm)</u>
•Argon fluoride (UV)	193
•Krypton fluoride (UV)	248
•Nitrogen (UV)	337
•Argon (blue)	488
•Argon (green)	514
•Helium neon (green)	543
•Helium neon (red)	633
•Rhodamine 6G dye (tunable)	570 - 650
•Ruby (CrAlO ₃) (red)	694
•Nd:Yag (NIR)	1064
•Carbon dioxide (FIR)	10600

Classes of Lasers

Based on the Biological Damage the Laser Can Cause

Class I: Lasers that don't produce any harmful radiation.

Class II: Lasers that are harmful if viewed for long periods of time. (The assumption is that people wouldn't let this happen.)

Class III: Lasers that are dangerous for short exposure. (*Many laser pointers are class III lasers!*)

Class IV: Lasers that can blind or burn after a very brief exposure. These can only be used under very controlled conditions.

USES OF LASERS

- ❑ They are used in precision tools and can cut through diamonds or thick metal.
- ❑ They can also be designed to help in delicate surgeries.
- ❑ Lasers are used for recording and retrieving information.
- ❑ They are used in communications and in carrying TV and internet signals.
- ❑ We also find them in laser printers, bar code scanners, and DVD players.
- ❑ They also help to make parts for computers and other electronics.

USES (Continued)

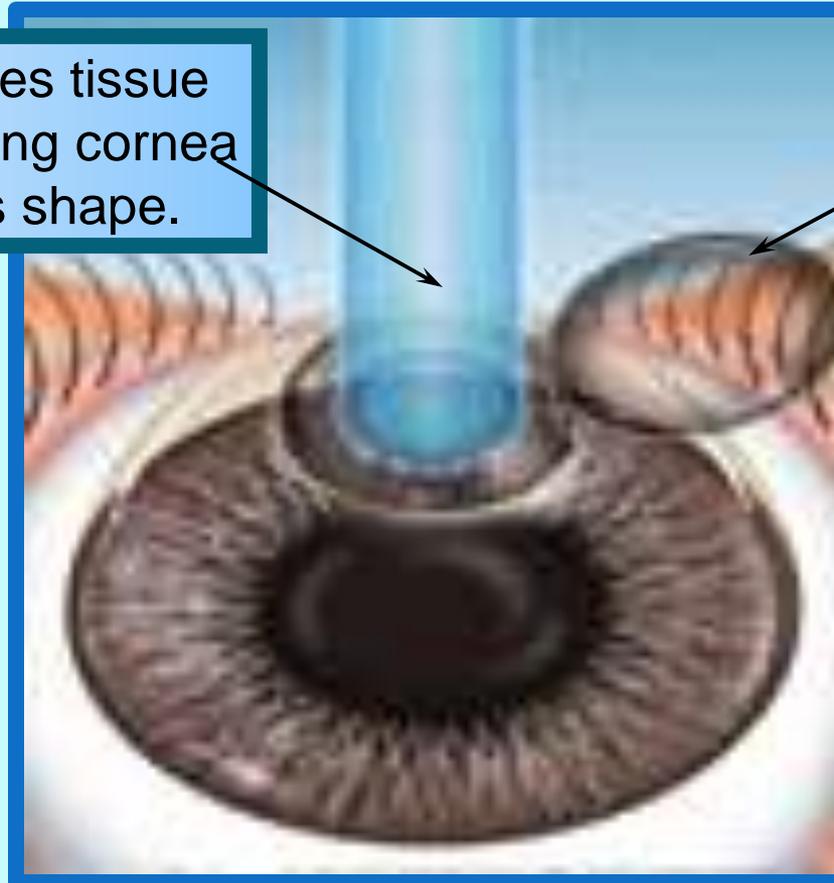
- Lasers have been used by NASA missions to study the gases in Earth's atmosphere.
- Lasers have also been used in instruments that map the surfaces of planets, moons, and asteroids.
- The distance between the moon and Earth can be calculated by using lasers! By measuring the time taken by a laser beam to travel to the moon and back, astronomers can calculate the exact distance between earth and moon.

Laser Eye Surgery

Laser in Situ Keratomileusis (Lasik)



2. Laser removes tissue from remaining cornea to change its shape.

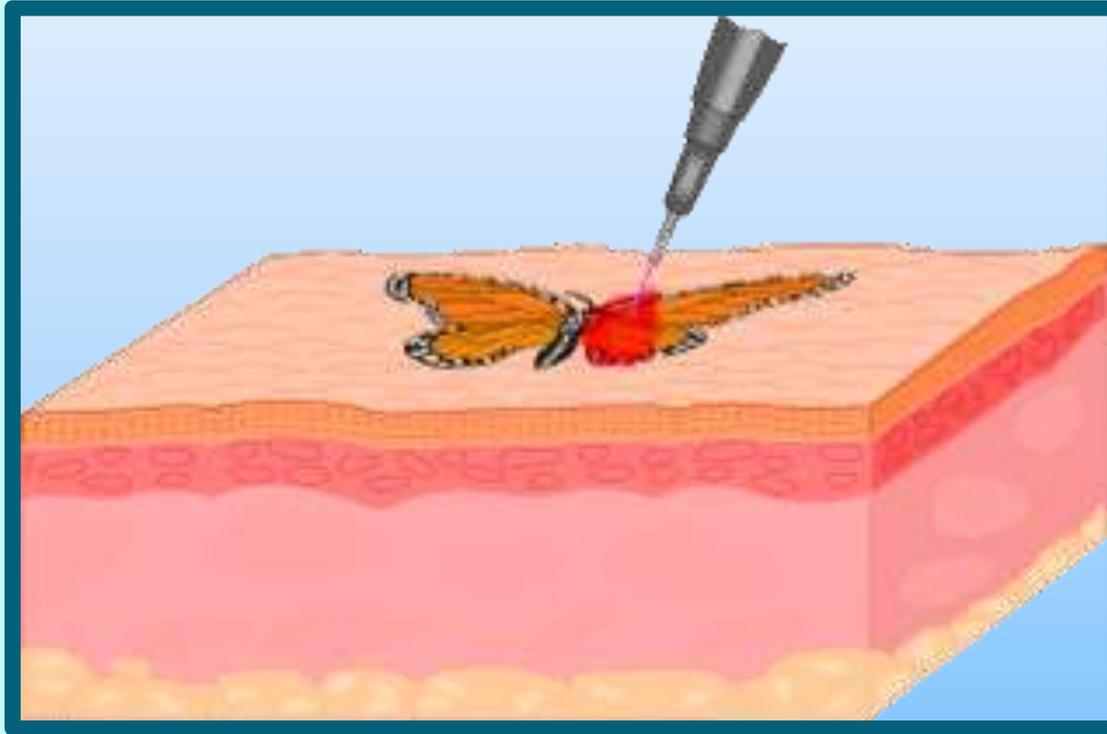


1. Tiny flap of outer cornea folded back.

3. Flap of outer cornea then reattached.

Laser Tattoo Removal

(Doesn't always work!)



The laser beam breaks up the pigments in the tattoo into small particles. Then the body's immune system attacks and destroys them.

Laser Gun Sights



Laser Targeting System

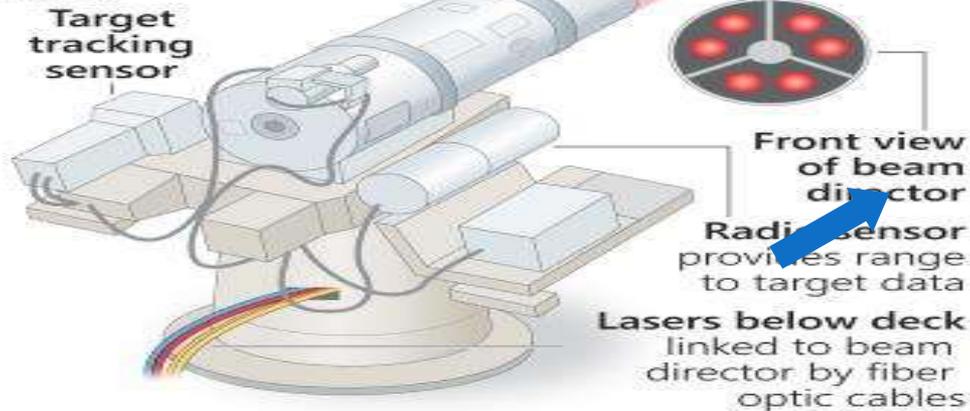
U.S. Navy to deploy new laser weapon

A prototype laser attack weapon will be deployed aboard the USS Ponce, a transport and docking ship assigned to the Persian Gulf, where fast Iranian attack boats have harassed U.S. ships and where the Pentagon thinks Iran will deploy and possibly arm surveillance drones. How it works:

ADVANTAGES

- Can be used to fire a bright warning flash
- Can lock on to moving target, assist heat-seeking missiles fired by friendly forces
- Limitless ammunition, the ship's generated electrical power

LASER WEAPON SYSTEM (LaWS)



DISADVANTAGES

- Line-of-sight needed to fire
- Rain, smoke can scatter beam
- Lacks power to attack incoming fast missiles or jet fighters

Laser delivers 100 kilowatts of energy

COUNTERING THREATS

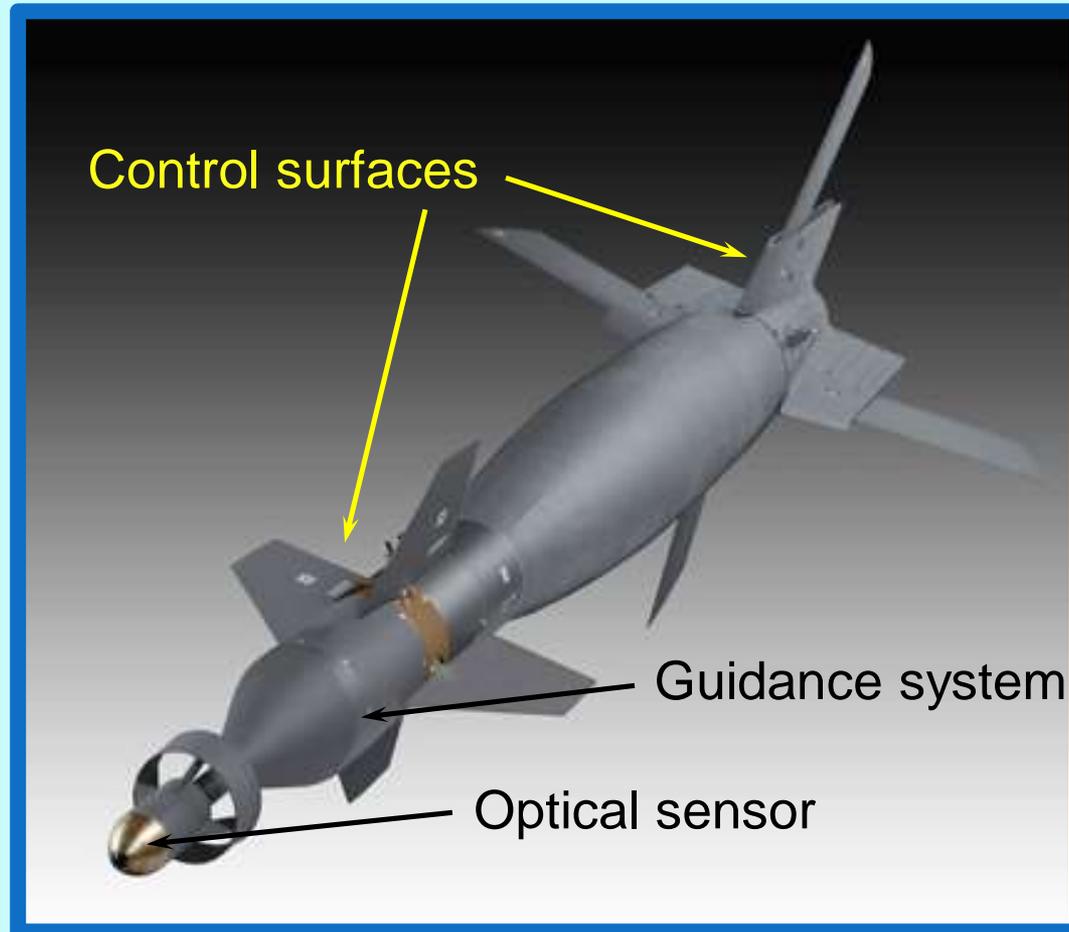
- 1. Small boats** Tracking laser beam can follow motion of such attack craft
- 2. Aerial drones** Laser can be used to blind drone's sensors, or burn it
 - Successful in 12 out of 12 tests
 - Far less expensive to use, \$1 per pulse, than firing \$1.4 million interceptor missiles



Source: U.S. Navy, Navy Times, Navy Live, New York Times

Laser Guided Bomb

(“Smart” Bomb)



Laser Targeting



2. Laser guided weapon tracks laser spot on target.

1. Laser targeting system "paints" target.



Laser Guided Missile

Hellfire laser guided missiles mounted on a US Army Apache helicopter gunship.



Newer variation (Hellfire II) replaces laser guidance with radar guidance to penetrate smoke and cloud cover.