Bharathidasan University

Tiruchirappalli – 620 024, Tamil Nadu, India

Programme: M. Sc., Physics

Course Title : **Lasers and Nonlinear Optics**

Course Code : **22PH401**

Unit I

Basics of Lasers

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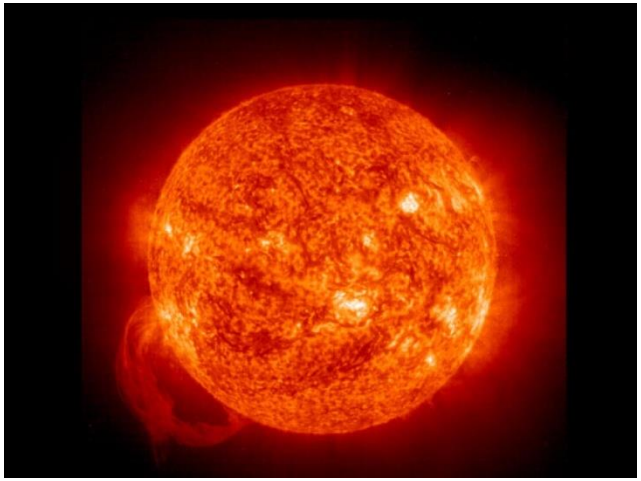
Various Light Sources

Lightning -
Electric Discharge

Volcano -
Incandescence



Sun -
Nuclear energy

Various Light Sources

Candle

Kerosene Lamp-
Combustion

Gas Mantle

Arc Lamp

Flash Tube –
Electric Discharge

Fluorescent Lamp

Various Light Sources

Bio-Luminescence

Aequorea victoria

Glow worm

Fire fly

Panellus stipticus

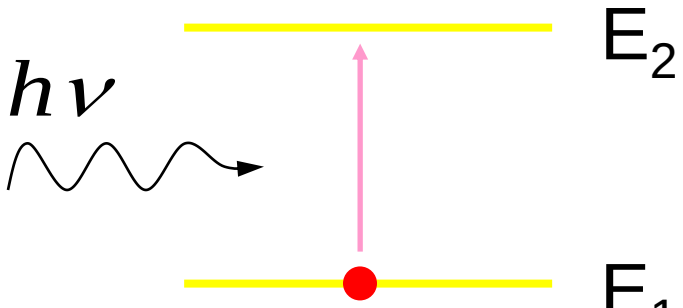
Cryo luminescence

Radio luminescence

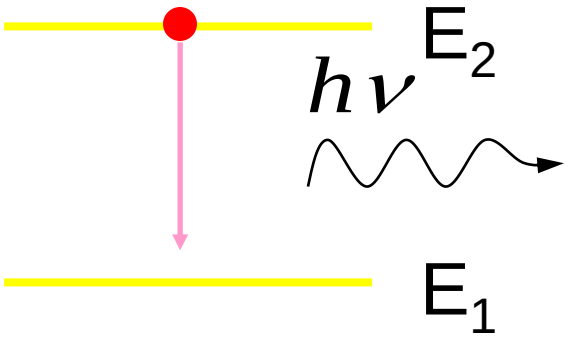
Electro luminescence

Optics is the study of interaction of electromagnetic radiations with matter.

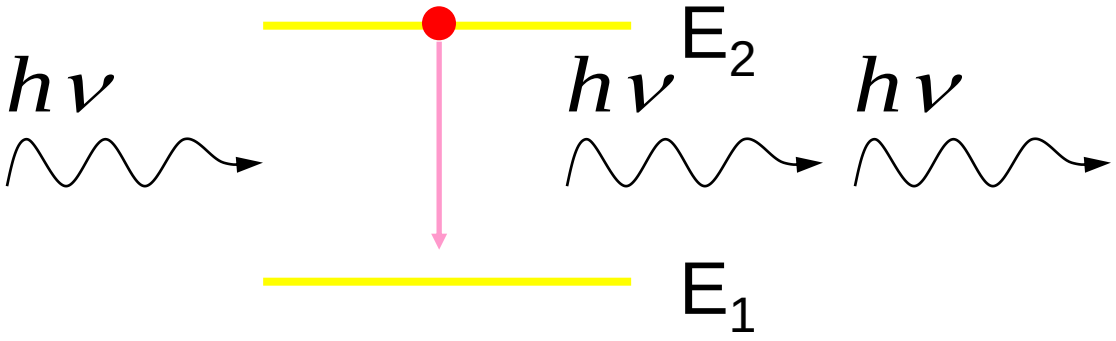
Interaction of Light with Matter…



Absorption

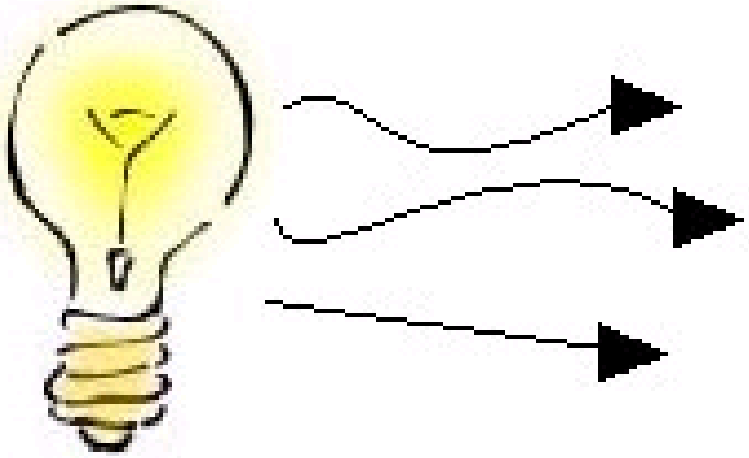


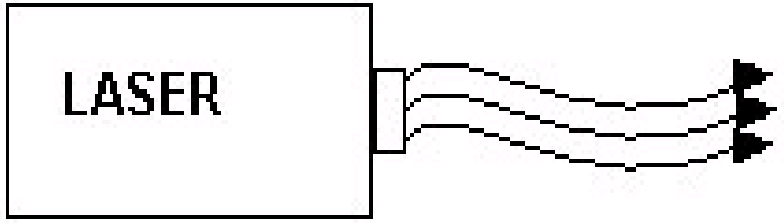
Spontaneous Emission



Stimulated Emission

Optics – Light Sources



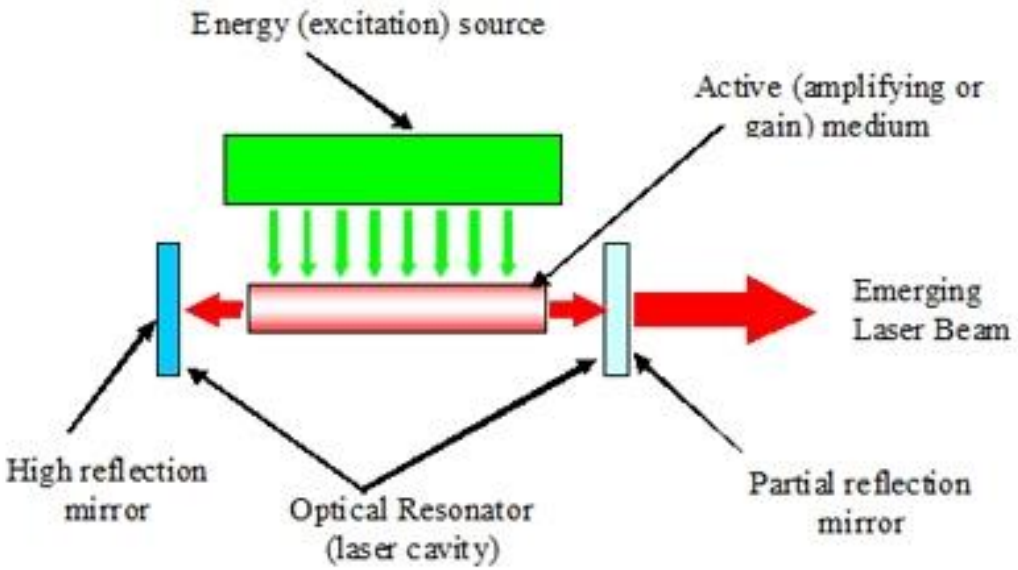


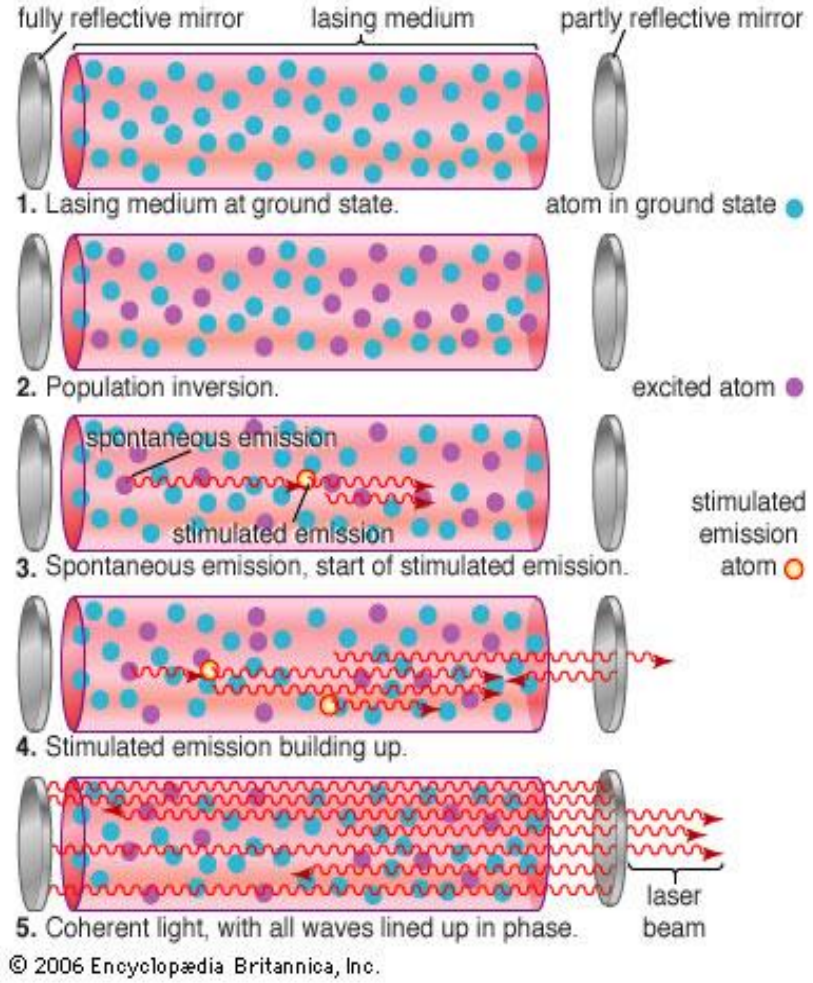
1. **Many wavelengths**
2. **Multidirectional**
3. **Incoherent**

1. **Monochromatic**
2. **Directional**
3. **Coherent**

Lasers – How it Works?

Light Amplification by Stimulated Emission of Radiation





Classification of Lasers

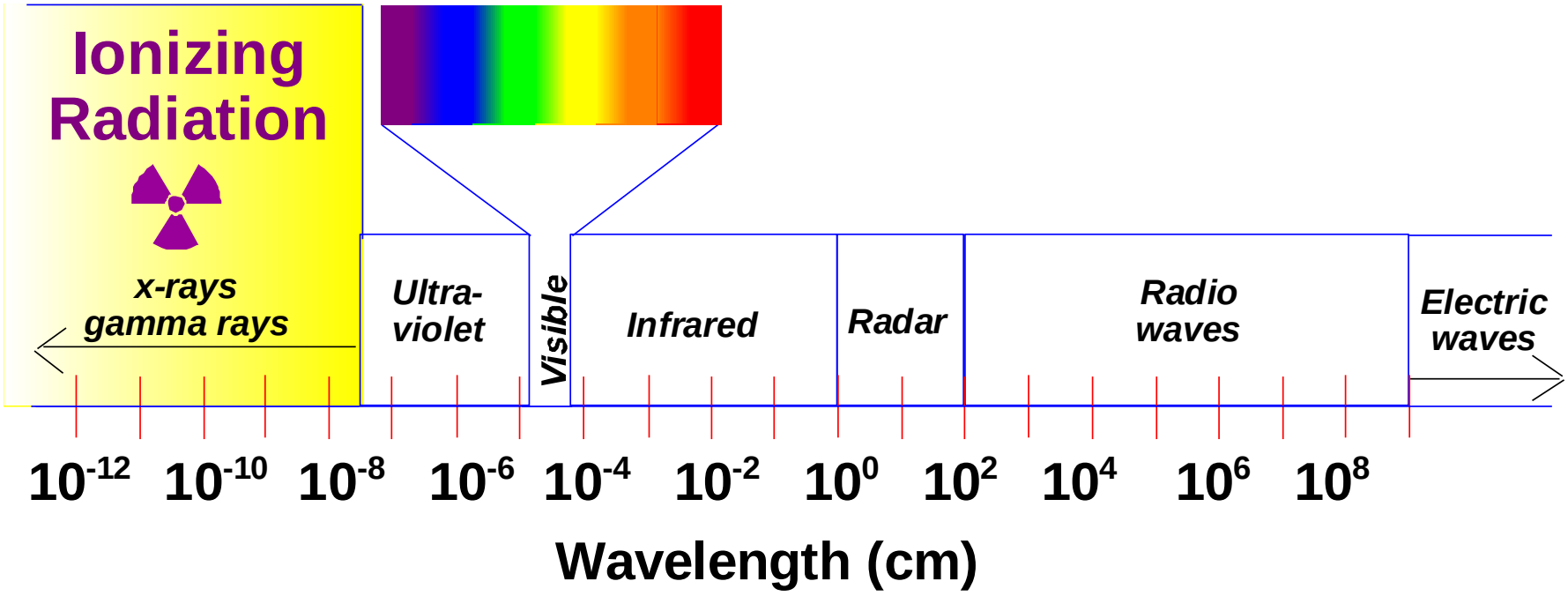
Lasers can be described by:

- which part of the electromagnetic spectrum is represented:
  - Infrared
  - Visible Spectrum
  - Ultraviolet
- the length of time the beam is active:
  - Continuous Wave
  - Pulsed (ns, ps)
  - Ultra-short Pulsed (fs)
- Conventional Lasers and USP Lasers

Is L of Laser Covers Entire EM Spectrum?

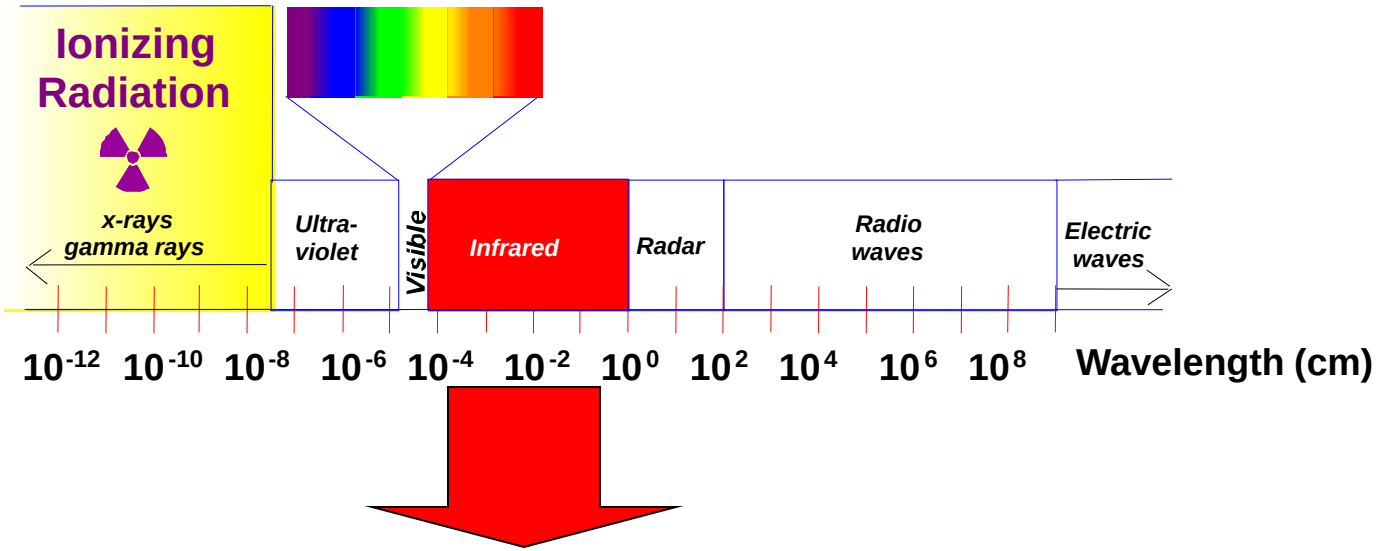
Laser wavelengths are usually in the Ultraviolet, Visible or Infrared Regions of the Electromagnetic Spectrum.

The Electromagnetic Spectrum



Common Infrared Lasers

Infrared radiation ranges from 760-10,000 nm.



Common Infrared Lasers								
Near Infrared							Far Infrared	
Ti Sapphire	Helium neon	Nd:YAG	Helium neon	Erbium	Hydrogen fluoride	Helium neon	Carbon dioxide	Carbon dioxide
800 nm	840 nm	1,064 nm	1,150 nm	1,504 nm	2,700 nm	3,390 nm	9,600 nm	10,600 nm

Common Visible Light Lasers

Violet	Helium cadmium	441 nm
Blue	Krypton	476 nm
	Argon	488 nm
Green	Copper vapor	510 nm
	Argon	514 nm
	Krypton	528 nm
	Frequency doubled Nd YAG	532 nm
	Helium neon	543 nm
Yellow	Krypton	568 nm
	Copper vapor	570 nm
	Rohodamine 6G dye (tunable)	570 nm
	Helium neon	594 nm
Orange	Helium neon	610 nm
Red	Gold vapor	627 nm
	Helium neon	633 nm
	Krypton	647 nm
	Rohodamine 6G dye	650 nm
	Ruby ($CrAlO_3$)	694 nm

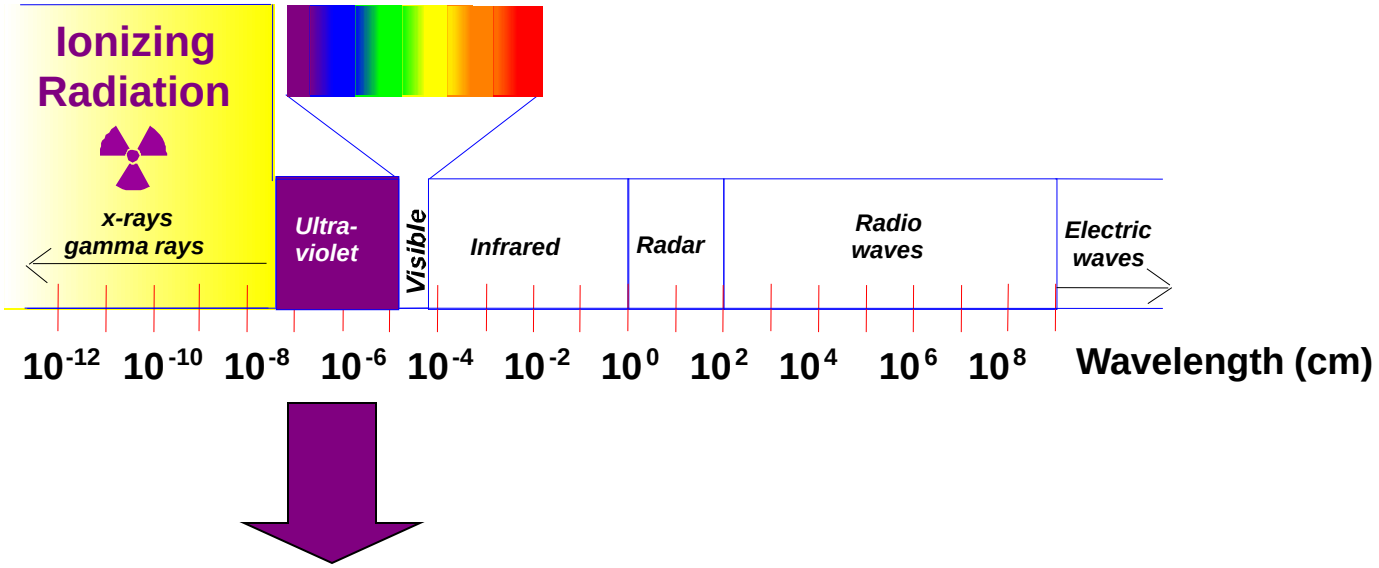
The wavelength range for light that is *visible* to the eye ranges from 400-760 nm.

Semiconductor – Diode Lasers

Fiber Optic Lasers

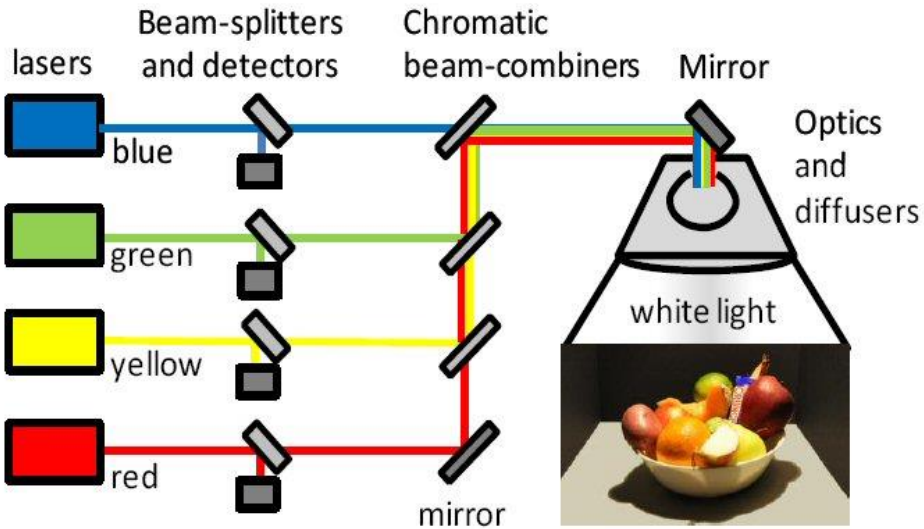
Common Ultraviolet Lasers

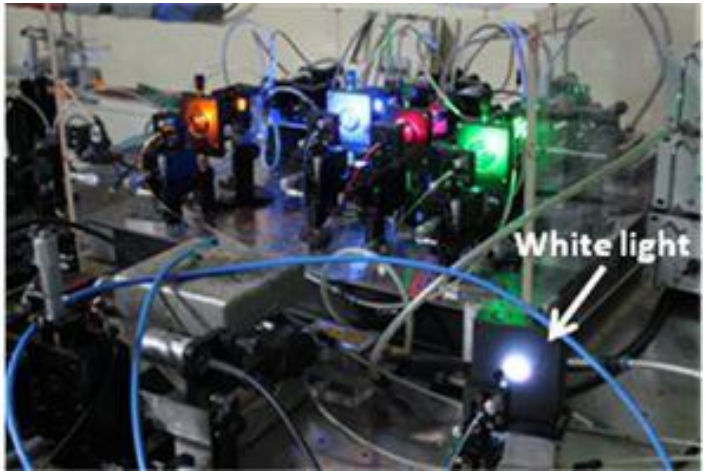
Ultraviolet (UV) radiation ranges from 200-400 nm.

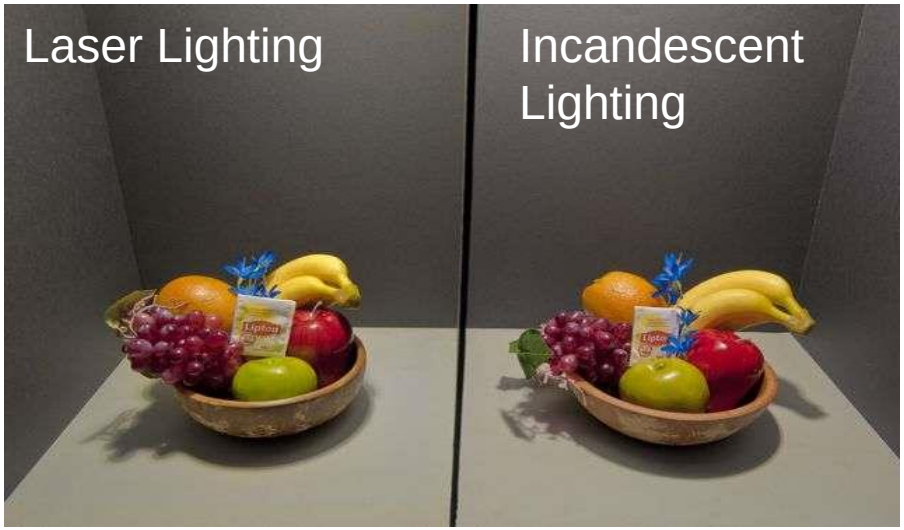


Common Ultraviolet Lasers						
Argon fluoride	Krypton chloride	Krypton fluoride	Xenon chloride	Helium cadmium	Nitrogen	Xenon fluoride
193 nm	222 nm	248 nm	308 nm	325 nm	337 nm	351 nm

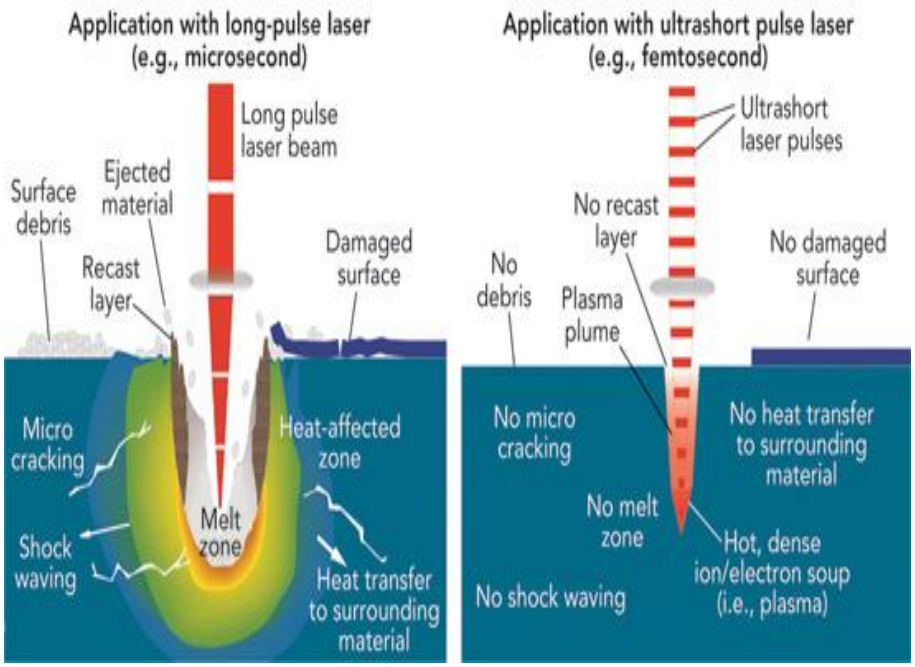
White Super Continuum Lasers

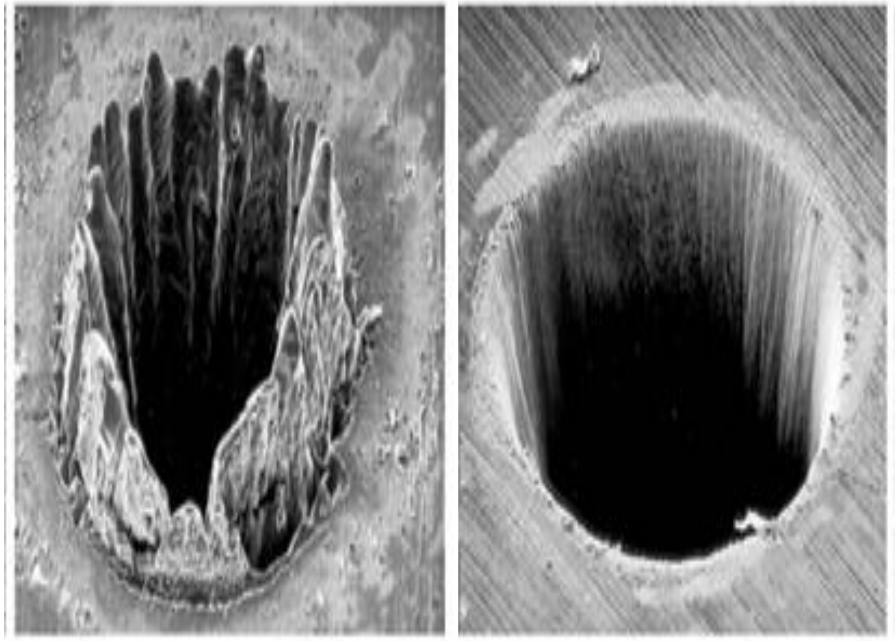






Long Pulsed VS Ultra Short Pulsed Lasers





Laser interaction with material under long and ultra-short pulse mode

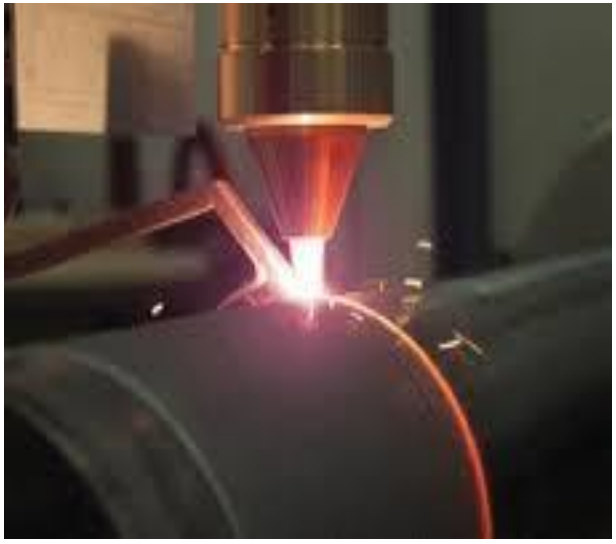
Laser drilling on metal surface with nano-pulsed and femto-pulsed laser

Applications of Lasers

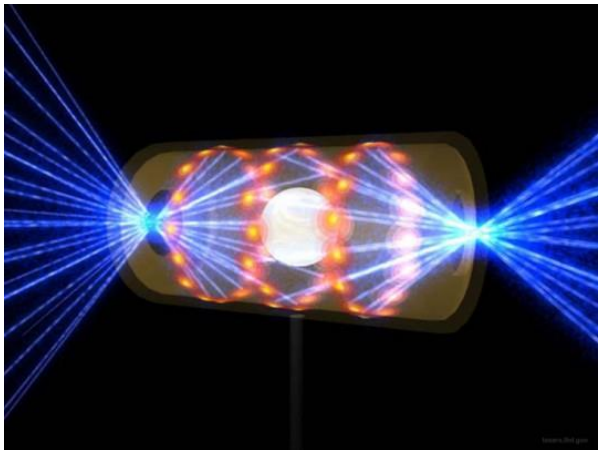
Laser: a solution looking for a problem (1960)

List is growing…

Laser is everywhere and is unavoidable (present scenario)



High Solid State Power Lasers – Futuristic Realization



LDEW

Books for Study:

1. **K.R. Nambiar**, Lasers: *Principles, Types and Applications* (New Age Inter-national Publishers Ltd, New Delhi, 2014).
2. **B.B. Laud**, *Lasers and Nonlinear Optics,* 3rd Edn. (New Age International Pvt. Ltd., New Delhi, 2011).
3. **Ralf Menzel**, *Photonics* (Springer-Verlag Berlin Heidenberg, New York, 2007)

Books for Reference

1. **Richard L. Sutherland**, *Handbook of Nonlinear Optics*, (Marcel Decker Inc, New York, 2003)
2. **R.W. Boyd**, *Nonlinear Optics, 2nd* Edn. (Academic Press, New York, 2003)
3. **W.T. Silfvast**, *Laser Fundamentals* (Cambridge University Press, Cambridge, 2003)
4. **Y.R. Shen**, *The Principles of Nonlinear Optics*, (Wiley & Sons, New Jersey, 2003)