# Glossary of Laser Definitions

* **Absorption of radiation –** Receiving electromagnetic radiation by interaction with the material, and transforming it to different form, which is usually heat (rise in temperature). The absorption process is dependent on the [wavelength](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#wavelength) of the [electromagnetic radiation](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#emr) and on the absorbing material.
* **Active Medium –** of atoms or molecules which can be [stimulated](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#stimulated_emission) to a [population inversion](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#pop_inv), and emit [electromagnetic radiation](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#emr) in a [stimulated emission](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#stimulated_emission).
* **Amplification –** The process in which the [electromagnetic radiation](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#emr) inside the active medium within the laser optical cavity increase by the process of [stimulated emission](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#stimulated_emission).
* **Amplitude –** The maximum value of a wave, measured from its equilibrium.
* **Anode –** The positive electrode of a [gas laser](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#gas_laser), used for [electrical excitation](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#excitation) of the gas in the tube.
* **Aperture –** A small opening through which the [electromagnetic radiation](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#emr) pass.
* **Argon Laser –** A [gas laser](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#gas_laser) in which argon ions are the [active medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium). This laser emits in the blue - green [visible spectrum](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#visible_spectrum), primarily at 488 and 515 [nm].
* **Attenuation –** The decrease in radiation energy (power) as a beam passes through an absorbing or scattering medium.
* **Beam Diameter –** Defined as the diameter of a circular beam at a certain point where the intensity drops to a fraction of its maximum value. The common definitions are 1/e (0.368) and 1/e2 (0.135) of the maximum value.
* **Beam Divergence –** Angle of beam spread, measured in [(milli)radians](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#milliradian). Can be approximated for small angle by the ratio of the beam diameter to the distance from the laser aperture.
* **Brewster Windows –** Windows at the ends of a gas laser, used to produce [polarized](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#polarization) [electromagnetic radiation](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#emr). The window is at Brewster angle to the optical axis of the laser, so only one type of [polarization](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#polarization) can pass through.
* **Brightness –** The visual sensation of the luminous intensity of a light source.
* **Carbon Dioxide (CO2) Laser –** A [gas laser](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#gas_laser) in which CO2 molecules are the [active medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium). This laser emits in the [infrared spectrum](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#ir_spectrum), primarily at 9-11 [µm], with the strongest emission line at 10.6 [µm].
* **Cathode –** The negative electrode of a [gas laser](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#gas_laser), used for [electrical excitation](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#excitation) of the gas in the tube.
* **Coherence –** A property of electromagnetic waves which are in phase in both time and space. Coherent light has [Monochromaticity](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#monochromatic_light) and low [beam divergence](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#beam_divergence), and can be concentrated to high power densities. Coherence is needed for interference processes like [holography](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#holography).
* **Diffraction –** A wave property which create deviation from a straight line when the beam pass near an edge of an opaque object.
* **Divergence –** Increase in beam diameter with distance from the aperture (see [beam divergence](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#beam_divergence)).
* **Diode Laser –** [Semiconductor Laser](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#semiconductor_laser)
* **Electromagnetic Radiation (Spectrum) –** A wave which propagate in vacuum with the speed of light, and composed of simultaneous oscillations of electric field and magnetic field perpendicular to each other, and perpendicular to the direction of propagation of the beam. Created by accelerating electric charge, and include X-rays, [visible spectrum](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#visible_spectrum), [infrared spectrum](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#ir_spectrum), microwave etc.
* **Electron Volt [eV] –** Unit of energy: The amount of energy that the electron acquire while accelerating through a potential difference of 1 [Volt]. 1 [eV] = 1.6\*10-19 [Joule]
* **Excimer Laser –** A [gas laser](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#gas_laser) which emits in the [UV spectrum](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#uv_radiation). The [active medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium) is an "Excited Dimer" which does not have a stable [ground state](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#ground_state).
* **Excitation –** Energizing the [active medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium) to a state of [population inversion](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#pop_inv).
* **Fluorescence –** of light of particular [wavelength](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#wavelength), as a result of [absorption of light](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#absorbtion_of_radiation) at shorter [wavelength](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#wavelength). It is a property of some materials; each material has a specific [wavelength](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#wavelength) of [absorption](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#absorbtion_of_radiation) and emission.
* **Frequency () (nu) –** The number of times that the wave oscillates per second (The number of periods of oscillations per second).
* **Gain –** see [Amplification](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#amplification)
* **Gas Laser –** laser in which the [active medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium) is a gas. The gas can be composed of molecules (like CO2), Atoms (like He-Ne), or ions (like Ar+).
* **Ground State –** Lowest energy level of an atom or molecule.
* **Helium-Neon (He-Ne) Laser –** A [gas laser](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#gas_laser) in which Helium (He) and Neon (Ne) atoms are the [active medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium). This laser emits primarily in the [Visible spectrum](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#visible_spectrum), primarily at 632.8 [nm], but also have some lines in the near Infrared.
* **Hologram –** An interference phenomena captured on a plate (or film). It can contain enormous amount of information and a 3 dimensional image can be constructed from it.
* **Injection Laser –** A type of laser which produces its output from semiconductor materials such as GaAs.
* **Infrared Spectrum (IR) –** Invisible electromagnetic radiation between 0.7-1,000 [µm].
* **Injection Laser –** see [Diode Laser.](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#diode_laser)
* **Ion Laser –** A laser in which the [active medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium) is composed of ions of a Nobel gas (like Ar+ or Kr+). The gas is usually [excited](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#excitation) by high discharge voltage at the ends of a small bore tube.
* **Irradiance (E) –** Radiant flux (radiant power) per unit area incident upon a given surface. Units: Watts per square centimeter. (Sometimes referred to as [power](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#power) density, although not exactly correct).
* **Laser –** An acronym for [Light](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#light) [Amplification](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#amplification) by [Stimulated Emission](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#stimulated_emission) of [Radiation](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#radiant_energy). A laser device is an [optical cavity](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#optical_cavity), with mirrors at the ends, filled with material such as crystal, glass, liquid, gas or dye. A device which produces an intense beam of light with the unique properties of [coherence](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#coherence), collimation and [monochromaticity](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#monochromatic_light).
* **Laser Accessories –** The hardware and options available for lasers, such as [Brewster windows](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#brewster_windows), [Q-switches](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#q_switch_laser) and optical components used to control laser radiation.
* **Laser Medium –** see [Active Medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium)
* **Laser Rod –** A solid-state, rod-shaped [active medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium) in which ion excitation is caused by a source of intense light ([optical pumping](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#optical_pumping)), such as a flash lamp. Various materials are used for the rod, the earliest of which was synthetic [ruby](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#ruby_laser) crystal (see [Solid State Laser](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#solid_state_laser)).
* **Laser Pulse –** A discontinuous burst of laser radiation, as opposed to a continuous beam. A true laser pulse achieves higher peak powers than that attainable in a CW output.
* **Lens –** A curved piece of optically transparent material which depending on its shape, is used to either converge or diverge light.
* **Light –** Usually referred to the [visible spectrum](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#visible_spectrum). The range of [electromagnetic radiation](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#emr) frequencies detected by the eye, or the [wavelength](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#wavelength) range from about 400 to 700 [nanometers](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#nanometer). The term is sometimes used loosely to include radiation beyond visible spectrum limits.
* **Limit Accessible Emission Level (AEL) –** Permitted within a particular class. In ANSI Z-136.1, AEL is determined as the product of Accessible Emission [Maximum Permissible Exposure limit (MPE)](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#mpe) and the area of the limiting aperture (7mm for visible and near infrared lasers).
* **Limiting Aperture –** The maximum circular area over which radiance and radiant exposure can be averaged when determining safety hazards.
* **Longitudinal (Axial) Modes –** Specific wavelengths in the laser output, determined by standing waves within the [laser cavity](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#laser_cavity). Only longitudinal modes under the laser gain curve, above the laser threshold are found in the laser output.
* **Maximum Permissible Exposure (MPE) –** The level of laser radiation to which person may be exposed without hazardous effect or adverse biological changes in the eye or skin.
* **Metastable State –** The upper laser level. An [excited state](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#excitation) of the atom or molecule, which have a long lifetime.
* **Micron –** Micro-meter, one millionth of a meter (10-6 [m]).
* **Milliradian –** A unit to measure angles, one thousandth of a radian. 1 milliradian [mrad] = 0.057°.
* **Mode locked –** A method of controlling the length of the output [laser pulse](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#laser_pulse) . Produce very short (10-12 [sec]) burst of pulses.
* **Monochromatic Light –** Theoretically, light at one specific [wavelength](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#wavelength). Practically, light with very narrow bandwidth. The light out of a laser is the most monochromatic source known to man.
* **Nanometer [nm] –** One billionth of a meter (10-9 [m]).
* **Nd:Glass Laser –** A solid-state laser in which a Nd doped glass rod is used as a laser [active medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium), to produce 1064 [nm] [wavelength](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#wavelength).
* **Nd:YAG Laser –** A [solid-state laser](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#solid_state_laser) in which Neodymium doped Yttrium Aluminum Garnet is used as a laser [active medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium), to produce 1064 [nm] wavelength.. [YAG](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#yag) is a synthetic crystal.
* **Neodymium (Nd) –** The rare earth element that is the active element in [Nd:YAG laser](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#nd_yag_laser) and [Nd:Glass lasers](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#nd_glass_laser).
* **Optical Cavity (Resonator) –** Space between the laser mirrors where lasing action occurs.
* **Optical Density –** A logarithmic expression for the [attenuation](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#attenuation) produced by an attenuating medium, such as an eye protection filter.
* **Optical Fiber –** A filament of quartz or other optical material, capable of transmitting light along its length by multiple internal reflection and emitting it at the end.
* **Optical Pumping –** The excitation of the [active medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium) in a laser by the application of light, rather than electrical discharge. Light can be from a conventional source like Xenon or Krypton lamp, or from another laser.
* **Optical Radiation –** [Ultraviolet](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#uv_radiation), [visible](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#visible_spectrum) and [infrared spectrum](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#ir_spectrum) (0.35-1.4 m) that falls in the region of transmittance of the human eye.
* **Optical Resonator –** The mirrors (or reflectors) making up the [laser cavity](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#optical_cavity) including the laser rod or tube. The mirrors reflect light back and forth to build up [amplification](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#amplification).
* **Output Coupler –** The part of the laser which enable light to come out of the laser. Usually it is a partially reflecting mirror at the end of the laser [optical cavity](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#optical_cavity).
* **Output Power –** The energy per second (measured in Watts) emitted from the laser in the form of [coherent light](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#coherence).
* **Photon –** The elemental unit of light. Quantum of light with energy (E) proportional to the wavelength () (lambda) (or frequency f). E = hf = hc /  (lambda). (  (lambda) = [wavelength](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#wavelength),  c = speed of light,  h = Planks constant).
* **Polarization –** Vibration of the electric field vector in specific direction perpendicular to the direction of propagation of the wave.
* **Population Inversion –** An excited state of matter, in which more atoms (or molecules) are in upper state than in a lower one. This is a required situation for a laser action.
* **Power –** The rate of energy delivery in a unit of time, expressed in Watts (Joules per second). Thus: 1 [Watt] = 1 [Joule]/1 [sec].
* **Pulse Duration –** The "On" time of a [pulsed laser](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#pulsed_laser).
* **Pulsed Laser –** Laser which delivers energy in the form of a single or train of[laser pulses](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#laser_pulse).
* **Pumping –** (See [Optical Pumping](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#optical_pumping)). Addition of energy (thermal, electrical, or optical) into active laser medium. Used to produce a state of [population inversion](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#pop_inv).
* **Q-witch Laser –** A laser which store energy in the active medium, to produce short pulse with high energy. It is done by blocking the resonator ability to oscillate, keeping the "Q-Factor" of the optical cavity low.
* **Radian –** A unit of measurement of angles. 2 [rad] = 360°, 1 [rad] = 57.3°.
* **Radiant Energy (Q) –** Energy in the form of [electromagnetic waves](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#emr) usually expressed in units of Joules (watt-seconds).
* **Radiant Exposure (H) –** The total energy per unit area incident upon a given surface. It is used to express exposure to [pulsed laser](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#pulsed_laser) radiation in units of J/cm2.
* **Reflection –** The return of [radiant energy](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#radiant_energy) (incident light) by a surface, with no change in [wavelength](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#wavelength).
* **Refraction –** The change of direction of propagation of any wave, such as an electromagnetic wave, when it passes from one medium to another in which the wave velocity is different. The bending of incident rays as they pass from one medium to another (e.g.: air to glass).
* **Ruby Laser –** The first laser type. A [solid state laser](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#solid_state_laser) which use a crystal of sapphire (aluminum oxide) containing trace amounts of chromium oxide as an [active medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium).
* **Scanning Laser –** A laser having a time-varying direction, origin or pattern of propagation with respect to a stationary frame of reference.
* **Semiconductor Laser –** (see [diode laser](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#diode_laser)) A type of laser which produces its output from semiconductor materials such as GaAs.
* **Solid Angle –** The ratio of the area on the surface of a sphere to the square of the radius of that sphere. It is expressed in steradians (sr).
* **Solid State Laser –** A laser in which the [active medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium) is in solid state (usually not including semiconductor lasers).
* **Spontaneous Emission –** Random emission of a [photon](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#photon) by decay of an [excited state](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#excitation) to a lower level. Determined by the lifetime of the excited state.
* **Spot Size –** A measure of the diameter of the beam of laser radiation.
* **Stimulated Emission –** [Coherent](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#coherence) emission of radiation, stimulated by a [photon](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#photon) absorbed by an atom (or molecule) in its excited state.
* **Transverse Mode –** The geometry of the power distribution in a cross section of a laser beam.
* **Transverse Electro-Magnetic (TEM) Mode –** Used to designate the shape of a cross section of a laser beam.
* **TEM00 –** The lowest order [transverse mode](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#transverse_mode) possible. The power distribution across the beam is of a gaussian shape.
* **Tunable Laser –** A laser system that can be "tuned" to emit laser light over a continuous range of [wavelengths](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#wavelength) or frequencies.
* **Tunable Dye Laser –** A laser whose [active medium](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#active_medium) is a liquid dye, pumped by another laser or flash lamps, to produce various colors of light. The color of light may be tuned by adjusting optical tuning elements and/or changing the dye used.
* **Ultraviolet (UV) Radiation –** [Electromagnetic radiation](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#emr) with [wavelengths](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#wavelength) between soft X-rays and visible violet light, often broken down into UV-A (315-400 [nm]), UV-B (280-315 [nm]), and UV-C (100-280 [nm]).
* **Visible Spectrum (light) –** [Electromagnetic radiation](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#emr) which can be detected by the human eye. It is commonly used to describe [wavelengths](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#wavelength) which lie in the range between 400 nm and 700-780 nm.
* **Wavelength () (Lamda) –** The length of the light wave. The shortest distance at which the wave pattern fully repeats itself, usually measured from crest to crest. The wavelength of light in the visible spectrum determines its color. Common units of measurement are the [micrometer (micron)](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#micron), the [nanometer](http://www.phys.ksu.edu/perg/vqm/laserweb/Glossary/#nanometer), and (old unit) the Angstrom unit. [[For more information click here]](http://www.phys.ksu.edu/perg/vqm/laserweb/Ch-1/C1s1t1p1.htm)
* **YAG = Yttrium Aluminum Garnet –** A widely used solid-state crystal which is composed of yttrium and aluminum oxides which are doped with a small amount of the rare-earth neodymium.