Types	Material	Properties
Solid-state lasers	(Nd-YAG) Crystal: $Y_2Al_5O_{12}$ (yttrium aluminum garnet, or YAG), with some of the Y ions replaced by Nd	• The transitions are between atomic energy levels • 4-level system: The Nd atomic levels are split by the electric field of the YAG crystal
Collisional gas lasers	Mixture of gases	• The transitions are due to collisions between the atoms: an excited electron from one gas transfers its kinetic energy to excite an electron in another gas molecule. • In a **He-Ne laser**, there are a large number of possible laser levels, but a specific wavelength can be selected by placing the laser in a resonant cavity (as one excites certain EM modes using a conducting cavity in ordinary electrodynamics.)
Molecular gas lasers	Gas	• The transitions are ***vibrational*** energy levels. • **CO_2** is a standard example: its triatomic structure provides a rich vibrational spectrum
Dye lasers	Liquid, organic dye dissolved in water or alcohol	• The transitions are related to the electron-transfer properties along chains of carbon atoms which give dye their characteristic color. (The laser, however, does not operate at the wave length of the ordinary visible color of the dye)
Semiconductor of diode lasers	Semiconductor	• The transitions are electron-hole annihilation between electrons in the bottom of the conduction bad and holes at the top of the valence band. (recombination radiation)
Free electron lasers	Collection of electrons, not bound to any atom or molecule	• When forced to accelerate back and forth in an external electric field, the electrons will emit bremsstrahlung at a frequency depending on their oscillation frequency