The Working of a Laser

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A Laser works on the principle of stimulated emission. An atom in an excited state can spontaneously return to its ground state by emitting a photon, a process known as spontaneous emission. However, when an atom in an excited state interacts with a photon of the right energy, it can be induced to de-excite to its ground state, by emitting another photon of the same energy. These 2 photons, having the same wavelength and energy, are said to be coherent. This process is called stimulated emission.
When light is shone at a sample of atoms, since most atoms are in their ground states, the predominant phenomenon is Absorption of incident photons, not Stimulated Emission. For Stimulated Emission to dominate, the proportion of atoms in the excited state must be increased. This process, called Population Inversion, is done via an external source of energy, such as light or electricity, which powers the laser.
For a material to undergo population inversion, possessing a ground state and an excited state alone is insufficient as in such materials, on attempting population inversion, when the number of atoms in excited state outnumber those in ground state, stimulated emission with incident energy predominates and prevents movement of a large fraction of atoms to the excited state. Therefore, materials with 3 states – a ground state, a highly unstable excited state, and a moderately stable excited state are used, as on application of energy, sample atoms sequentially jump to the excited state to then immediately accumulate in the moderately stable state, thereby causing population inversion. Once population has been inverted, light of the required energy is shone on the sample. This causes stimulated emission to occur and increases the number of photons of that energy. In most lasers the ends of the cavity containing the sample are designed to be reflective so that photons repeatedlycause stimulated emission, causing their number to grow rapidly. One end of the laser cavity is designed to be slightly transmittive, so that a beam of monochromatic, coherent light escapes in the form of a laser beam.