

LASERS

- Lasers have been developed by a wide range of physicists, and are used in many everyday applications
 - Hull University develops the idea of X-ray lasing
 - Most communications today use laser technology

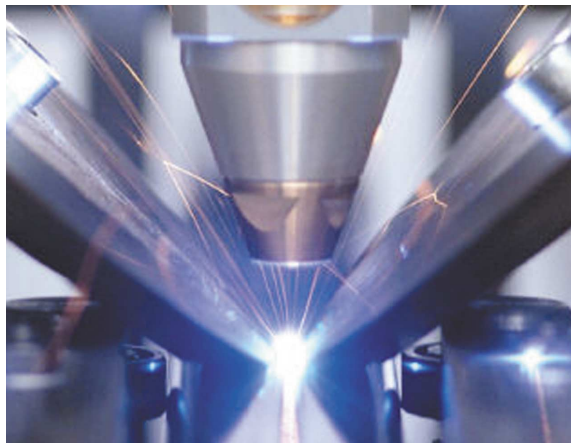
What is it

Almost all modern communications, including everything from cable television to the Internet, are carried on digital pulses of focused, high-intensity light called a laser. Where a lightbulb can emit light over a wide spectrum in a spread area, a laser emits light in a narrow, well-defined, single wave.

Many people used to think that lasers could only be used as weapons. This is of course not the case. Today, for example, lasers are used in corrective eye surgery, providing a precise source of heat for cutting and cauterizing tissue. They're found in shops, where they scan barcodes for product information. CD and DVD players use lasers to read and write data, and they can also be found in high-security systems such as in banks, museums and art galleries.

Physicist Theodore "Ted" Maiman, the inventor of the first laser alongside his team, also developed some of the first laser weapons-sighting systems. Research into lasers is still finding new applications for the technology on a regular basis.

For example, lasers are used in the continuing development of holograms, and also the much publicized research into the prospect of teleportation devices. Although the idea is regarded by some as science fiction, teleportation of the properties of an atom was achieved in 2002 by the use of laser technology. This landmark experiment is being viewed as a major advance in the quest to achieve ultra-fast computers, inside which teleportation could provide a form of invisible "quantum wiring". This is the principle of transferring data by lasers in a circuit, negating the need for wires, with the bandwidth capped only by the speed of light. This could lead to processing speeds faster than we can imagine.



The science

Physicist Albert Einstein was a visionary. His theories and research are still an integral part of science today, and Einstein was the driving force in the development of the laser. The principle of the laser was first known in 1917, when he described the theory of stimulated emission. Stimulated emission is when an atom, ion or molecule is excited to a higher energy level by an electric charge or other means. At this stage, it will spontaneously emit a photon as it decays to its original state. If that photon passes near another atom of the same

frequency, the second atom will be stimulated to emit a photon. Both photons will be of the same wavelength and phase, and are perfectly aligned. Light amplified in this manner is intense, of a single wavelength and moves solely in one direction. In short, laser light. However, it was not until the late 1940s that engineers began to develop and use this principle for practical purposes. By the 1950s, several different engineers and physicists were working towards the harnessing of energy, using the principle of stimulated emission.

At this stage engineers and physicists were working towards the creation of what was termed a maser, a device that amplified microwaves as opposed to light and soon found use in microwave-communication systems. Microwaves are very similar to other communication tools such as radio waves; they just differ in size. Therefore microwaves can also be used to carry data, and not just cook your food!

Physicist Charles Townes believed it was possible to create an optical maser, a device for creating powerful beams of light using higher-frequency energy to stimulate what was to be termed the lasing medium. Despite his pioneering work, it was left to Maiman in 1960 to invent the first laser using a lasing medium of ruby that was stimulated using high-energy flashes of intense light.

The laser was a technical breakthrough, but in its early years it was a technology with no practical application. It was not powerful enough for use in beam weapons envisioned by the military, and its usefulness for transmitting information through the atmosphere was severely hampered by its inability to penetrate clouds and rain. Fibre-optic research helped laser technology by providing a platform for controlled and efficient transit, enabling communications worldwide and contributing to technical advancements over the latter part of the 20th century.

Laser timeline

1917	Physicist Albert Einstein develops the concept of “stimulated emission”, which later evolves into laser light.
1947	Physicists Willis E Lamb and R C Rutherford demonstrate stimulated emission for the first time.
1951	Physicist Charles H Townes and colleagues conceive the maser, the first device based on stimulated emission. He is awarded the Nobel prize in 1964. Physicist Joseph Weber also comes up with the concept of masers and lasers. He presents his ideas in a talk at a conference in 1952, and publishes the first open-literature paper on what is now called quantum electronics.
1958	Physicists Arthur L Schawlow and Charles H Townes first detail a paper describing an optical maser. They are also credited with the invention of the laser.
1960	Schawlow and Townes patent their laser technology. Physicists Peter P Sorokin and Mirek Stevenson create the first uranium laser, and the second laser overall.
1962	Physicist Robert Hall invents the semiconductor laser.
1969	Lasers find their first industrial application when they are used in car manufacturing.
1970s	Physicist Gordon Gould patents technology now used in most industrial, commercial and medical applications of lasers.
1980	Hull University’s group of physicists, led by Geoffrey Pert, first reports X-ray lasing action.
1984	The first reported demonstration of a laboratory X-ray laser takes place.
1985	Compact discs are introduced. A low-power laser beam reads data that have been encoded in the form of tiny pits on an optical disc. The drive then feeds the data and converts the signal into music.
1992	US admits to testing lasers as an anti-satellite measure.
1994	Laser technology first trialled in the UK to inform drivers of excess speed. The technology is later rolled out across the country.
2001	University of St Andrews develops a helix laser that can manipulate and move small objects. Japanese scientists create an object the size of a blood cell using a laser.
2002	Australian scientists succeed in teleporting a laser beam from one place to another almost simultaneously.
2003	Laser scanning by the British Museum could one day lead to virtual exhibitions.
TODAY	Intel scientists discover a way to put a silicon-based laser on a chip, raising hopes of much faster networks.

The future

Only recently have the two manufacturers of DVDs (Sony and Philips) finished development of the next generation of High-Density DVD. Both companies have moved to using blue lasers instead of red, because of the huge increase in storage capacity. Blue laser light has a smaller dimension than red laser light, allowing the same amount of data to be written in a smaller area. Continued research into laser-enabled storage could one day lead to entire encyclopaedias being on a disc the size of a 10p coin.

Developments in laser technology could also lead to significant advances in areas such as the treatment of disease, quantum computing and security technologies.

Physics has been key to the creation, research and development of lasers, and scientists believe that there is still much more to be learnt in terms of applications for the technology. Continued research can only benefit the world as a whole, with new applications for lasers being found every day. UK teams hope to be at the forefront of this research.

Lasers in entertainment

Commonly used in CD and DVD players, lasers have also been used to create spectacular light shows as seen in London during the Christmas period and worldwide during the millennium celebrations.

Lasers in medicine

The surgical laser allows surgeons to access the most remote areas of the body, through tiny incisions or sometimes no incision at all. Compared with conventional surgery, laser surgery can mean less pain, less blood loss and less time in the hospital. It also means reduced scarring and recuperation time.

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