Lasers

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Since the invention of the ruby laser in 1960 many fantastic laser inventions, developments and applications have appeared, starting with the original enormously huge ruby laser systems taking the space of half a laboratory and emitting extremely noisy sounds when discharging and ending up now with the modern solid state laser systems that are small, robust and transportable and yet very powerful systems.

Although laser light is nothing else than light concentrated optimally in the space and frequency domains, the applications have been numerous and sometimes even governed by fantasy and wishful thinking. One or the more drastic examples is the 'Star War' project from the Reagan period that implied an incredible injection of funding into laser related projects and indeed implied a lift for the industry and the companies and, indeed, contributed to the end of the cold war and a new world order on the Planet. Therefore the laser is a technological invention that has actually influenced our history.

Furthermore this invention has implied a revolution in the communication system around the Planet due to the fiber optic communication devices developed during the last 30 years. The bandwidth and quality of the communication between nations have been immensely improved, and the nations have, in reality, been brought closer together by this network of fiber optic cables in a common community that hopefully sooner or later will end up in the 'United Nations of the Earth' where the individual inhabitants will feel more like a citizen of the Earth than a citizen of some specific nation.

Why has the laser invention been so successful? This is probably due to the possibility of concentrating energy so strongly both spatially and spectrally. This kind of concentrated energy is easy to handle and operate. It can be directed everywhere without much trouble. The energy of the laser is based on electromagnetic wave energy which is of course very fundamental and, in fact, one of the building stones of all physical material. Yet, one may wonder why a similar invention has not yet appeared for other kind of waves. Ultrasonic waves, for instance, can easily get into the same wavelength range as optical waves, and therefore be produced in beams similar to the well known laser beams with applications of similar kinds. This is an invention that may appear within a few years, and it will most certainly imply an industrial revolution similar to that experienced during the development of the laser technology.

About the special section

In this issue of DOPS-NYT we shall focus on some of the lasers of year 2002. Nowadays lasers are very compact systems. The revolution experienced by electronics during the 1960's where the radio tubes were replaced by transistors which were later on replaced by integrated circuits is now taking place in the laser technology regime where old fashioned large glass laser tubes are being replaced by solid state laser diodes capable of emitting even more power than the original glass lasers. Probably the future will introduce integrated laser types built into photonic circuits with parallel processing possibilities yielding an enormous capacity of computing power for future computers. We are now in this stage of miniaturizing and integrating optical components, and many of the laser systems constructed today will, although they now seem compact, in the future be considered as 'huge systems'.

One of the aspects of laser technology today is the possibility of tuning the wavelength emitted from the laser. For a long time tunable lasers were synonymous with dye lasers and later on also with the Ti:Sapphire laser, but now the possibility of tuning diode lasers has become important, too. Wavelength multiplexing is a technique that is being widely used in order to increase the bandwidth of optical communication systems. It is therefore necessary to develop lasers that can easily change the wavelength of their emission. Jens Buus from Gayton Photonics Ltd. writes in more detail about these possibilities.

The optical parametric oscillator (the 'OPO') described by Haim Abitan from Dep. of Physics, DTU also deliver tunable laser emission. The OPO was invented already a few years after the laser itself and some systems were constructed, but never developed into a state that were suitable for commercial systems. During the last ten years the OPO has experienced a renaissance that will probably result in stable well functioning tunable systems. The OPO-system reported by Haim Abitan seems to be very stable and efficient.

Morten Bruun-Larsen from Asah Medico A/S reports on a diode laser system for skin treatments that are very compact and very efficient. The output power from the fiber tip is 90W, and the system is portable and easy to operate. A single diode laser cannot emit more than about 50-100 mW without catastrophically damaging the cavity. Hence diode lasers emitting multiwatts of laser power must be build up of many stripes of single diode lasers arranged in arrays or even in stacked arrays. Hence, the beam emitted from such diode laser systems is a beam composed of hundreds of individual laser beams and therefore with very poor coherence properties. Paul Michael Petersen from Research Center Risø describes a laser system where advanced optical technology is incorporated in the cavity design in order to improve the coherence properties of the emitted laser beam.

It has been a privilege to be a guest editor on this section on lasers of the present issue of DOPS-NYT, and I wish to thank all the authors for their interest and contributions to this topic.