SYLA 1: 50 Years of Lasers I

Time: Wednesday 14:00–16:00 Location: E 415

Invited Talk SYLA 1.1 We 14:00 E 415
How the laser happend — •Herbert Welling — Leibniz Universität Hannover

After the realization of masers, microwave oscillators with an entirely new concept of amplification -namely by stimulated emission of radiation, scientists around Charles Townes at Columbia University and Arthur Schawlow at Bell Telephone Laboratories started to think how the new concept could be transferred to oscillators in the infrared and even visible region to generate there coherent radiation. However it turned out that a tremendous amount of research had to be done to achieve in an atomic or molecular ensemble a population inversion and to develop optical resonators with adequate size and Q-values.

The first laser was realized in July 1960 at the Hughes Aircraft Research Laboratories by T. H. Maiman using ruby as the active material; his achievement came entirely as a surprise, but it was not an accidental discovery. The laser is just a new light source but his radiation shows superiority in coherence in space and time and offers the potential of high intensity. After Maimans invention in 1960 in many famous laboratories all over the world research was intensified to find new laser materials, to find atomic and molecular systems suited to generate population inversion, and theoretical and experimental work was concentrated to understand the spatial and temporal coherence of the laser radiation.

Invited Talk SYLA 1.2 We 14:30 E 415
The origin of the quantum theory of lasing — •Fritz Haake — Universität Duisburg-Essen

The realization of the laser in 1960 was followed by intensive theoretical work worldwide. Hermann Haken and his Stuttgart school pioneered the quantum treatment in terms of nonlinear Langevin equations. A Schrödinger-picture description by master equations followed.The qualitative picture of slow phase diffusion and a rather stable modulus of the light-mode amplitude emerged. The near-threshold behavior was captured by a Fokker-Planck equation for a van der Pol type oscillator.

The analogy of the laser threshold with critical points of second-order phase transitions was discovered and the field of non-equilibrium phase transitions thus inaugurated. Further ramifications included the extension of the basic ideas towards chemical, biological, and even social systems.

The quantum theory of lasing came into new blossom when in the nineties lasers were pushed to the quantum noise limit and light squeezing was implemented.

Invited Talk SYLA 1.3 We 15:00 E 415
Lasers for precision measurements — •Thomas Udem — Max-Planck-Institut für Quantenoptik

From the very beginning the laser was used as a valuable tool for research. A large amount of precision data about atoms and molecules has been obtained with narrow band single mode lasers. For the utmost precision frequency stabilization and counting techniques have been key ingredients. In 1983 the possibility to count optical cycles was used to re-define the meter in terms of the speed of light. The purpose was to remove an artefact from the SI units. Improved laser spectroscopic techniques have led to some of the best tests of quantum electrodynamics and the possibility to operate optical atomic clocks. These clocks are now taking over the lead as the most precise instruments enabling new tests of fundamental theories such as general relativity. As one of the latest developments lasers are getting used as calibration tools for precision astronomy and might help to find Earth-like extra solar planets. Eventually the precision might be sufficient to directly observe or rule out cosmic acceleration that is believed to be due to the prevalence of dark energy.

Invited Talk SYLA 1.4 We 15:30 E 415
Short, Ultra Short, Atto Short — •Dietrich von der Linde — Universität Duisburg-Essen

One of the major lines of development that started off with the invention of the laser was the search for ever shorter and more intense laser pulses. Due to a succession of new ideas and techniques the attainable laser pulse duration has dropped in several steps all the way to femtoseconds (10-15 s) and is entering today the attosecond (10-18 s) time regime. The spectacular progress in time resolution and also in peak intensity has provided new research tools and opened up exciting new applications in science and technology.