FOREWORD
Special Issue on "LASERFEST-50"

VALENTIN I. VLAD, Chief Editor of *Romanian Reports in Physics*

This special issue of *Romanian Reports in Physics* is dedicated to the 50th celebration of the laser discovery by Theodore H. Maiman, in mid-May of 1960, at Hughes Research Labs., Malibu, USA [1].

This discovery followed a number of fundamental scientific results and discoveries: Einstein's theory of absorption, emission and stimulated emission (1916); the results on optical pumping and light amplification obtained by A. Kastler and J. Brossel (1949), the "maser" (in ammonia) discovered by Ch. H. Townes, Al. M. Prokhorov and N.G. Basov (1954), the invention of continuously pumped solid-state maser by Bloembergen and Dicke (1956) and the quest of the more challenging "optical maser" (named "laser" in 1959, by G. Gould, one of Townes'students) [2-5, 8].

Maiman won a tight race to obtain the first laser due to some reasons, which deserve to be mentioned for history of physics: (1) critic observation of (Townes' and Schawlow's) previous views and research on selecting the right active material (particularly in the quantum 3-level scheme of emission and efficiency of pink ruby crystals); (2) the simplicity of its laser components and structure; (3) the pulsed optical pump by an usual (photographic) flashlamp. His first paper sent to "Physical Review Letters" was rejected (as other valuable papers in this rapid developing field), he did not receive Nobel Prize, but he is recognized now (after he passed away, in 2007) for laser discovery. After his discovery, a lot of scientists built the new device and many other laser systems.

In October 1962, the first Romanian He-Ne laser was operated in the Institute of Atomic Physics, Bucharest-Magurele, in the "Laboratory of Optical Methods in Nuclear Physics", lead by Ion Agarbiceanu (L. Blanaru's team). This result was obtained shortly after the discovery (in December 1960) of the first gas laser by A. Javan, W. R. Bennett, Jr and D. R. Herriott, at Bell Labs, USA. The Romanian achievement, which was all the more outstanding in view of the modest circumstances of its occurrence, was reported in the paper "Contributions á l'étude des lasers aux gas" by I. Agarbiceanu, A. Agafitei, L. Blanaru, N. Ionescu-Pallas, I.M. Popescu, V. Vasiliu and V.G. Velculescu, Proc. 3d Intl. Congress on Quantum Electronics, Paris, 11–15 February 1963.

In 1960-70, a large number of laser systems and laser applications were investigated. We can mention solid-state lasers and carbon dioxide lasers and

applications as nonlinear optics (P. Franken, N. Bloembergen, J. Ducuing, P.S. Pershan, S.A. Akhmanov, R.V. Khokhlov et al), holography (D.Gabor, E. N. Leith, J. Upatnieks et al), material processing, communications, medical treatment, metrology (telemetry) etc. However, the limited success of first lasers in applications created an opinion that they are a bright solution looking for a problem.

The situation was changed in seventies, when the argon ion laser became commercial, C.W. double-heterostructure semiconductor lasers were operated at room temperature (Zh. I. Alferov, H. Kroemer), optical fibers were produced with low losses (Ch. Kao, E. Spitz, A. Werts et al), pico- and femto-second dye lasers had major developments (by advances in mode-locking), high power carbon dioxide lasers with fast longitudinal flow were created and a large number of optical materials became available for laser applications.

In 1980-90, the solid-state lasers with femtosecond pulses, in which the optical nonlinearities were controlled and exploited (chirp pulse amplification – CPA, D. Strickland and G. Mourou [6], O. Svelto, W. Sibbett et al) and the fiber lasers in NIR range appeared, were developed in many laboratories and were used for high harmonic generation (to X-ray region), comb generation and applications (Th. Hänsch, J. L. Hall). Lasers were used in many instruments and industrial equipments, in many medical instruments for imaging, surgery and therapy and in military equipments. Many laser applications were also developed in the Institute of Physics and Technology for Radiation Devices (IPTRD), Bucharest-Magurele, a follower of Agarbiceanu's laboratory. Here, Ioan Ursu and Al. M. Prokhorov organized a series of international conferences "Trends in Quantum Electronics" (TQE), in which many new results in the field were presented and entered in the international flux, in a part of our history, when researcher communication and mobility were strongly restricted.

In nineties, the solid-state lasers with femtosecond pulses arrived to focused intensities in the range of terra-Watts, usable for relativistic optics and high density plasma (with potential in controlled fusion and thus, laser inertial fusion energy production). The new field of attosecond light pulses (generated by electrons under femtosecond laser excitation and first observed by F. Krausz-MPQ, Germany) [7] will allow the observation of many phenomena in the world of electrons and information processing to its frontiers. The increasing mobility and participation in the international projects lead to a better presence of the results of Romanian laser scientists in the main journals and to new impetus of IPTRD, in a new structure and name, the National Institute for Laser, Plasma and Radiation Physics (www.inflpr.ro). Each three years, an international conference "ROMOPTO" continued the series of "TQE" conferences and the proceedings volumes were published by the International Society for Optical Engineering (SPIE Digital Library, USA). In 2012, we shall organize the 10^{th} edition of this conference.

Prof. Charles H. Townes, the first Nobel laureate for the maser and laser discovery, writes: ""lasers have now become a very important and widely used

technology, as well as very useful tools for exciting science, which was my primary purpose in the invention. By now, there have been 15 persons winning Nobel prizes which depended critically on masers or lasers. Applications of lasers have grown spectacularly and now involve many billions of dollars of sale per year" [4]. Prof. Orazio Svelto mentioned recently: "the laser, initially considered as a bright solution looking for a problem, can now properly be indicated as the bright solution of many problems in science and technology" [5]. This century is considered by some specialists the century of photonics, having the laser as leading vector.

What next? A new era of ultra-intense lasers was launched with peta-Watt lasers now commercially available and perspectives for exa-Watt lasers, which could bring fundamental observations in particle physics, nuclear physics, nonlinear field theory, astrophysics, new energy sources, ultrahigh-pressure physics and many others [6, 7]. Romania is one of the three pillars of the European project "Extreme Light Infrastructure" (ELI), with a specific photo-nuclear target (www.nipne.ro).

LASERFEST-50 is celebrated overall the world (www.laserfest.org). The Romanian physics community, as well as our foreign friends and collaborators, join some of their contributions in this special issue of *Romanian Reports in Physics*, one of our celebrations dedicated to LASER discovery and to its strong implications in our life. The papers in this issue report new results in laser and laser systems, laser interactions with matter, laser nonlinear interactions with matter, laser in biophotonics and laser instrumentation.

I hope that this special issue reflects some important directions of research in the modern laser physics and some important results of the most active laser scientists in Romania. I express my full appreciation to the authors, to the distinguished members of the Editorial Board, as well as to the competent reviewers for their efforts in the paper selection. Finally, the technical staff of this Journal, particularly Mrs. Margareta Oancea and the publishers from the Publ. House of the Romanian Academy, is warmly acknowledged for the dedication and energy in publishing this journal issue.

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