BOOK REVIEWS

Tunable lasers: a new stage

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Tunable Lasers, Eds. L. F. Mollenauer and J. C. White, Springer-Verlag, Berlin; Heidelberg; New York; Tokyo, 1987. 404 pp.

The first frequency-tunable source of coherent optical radiation—a parametric light generator—was constructed in 1965, five years after the ruby laser became operational.

In 1966 reports appeared that laser action had been obtained in solutions of organic dyes—laser materials that have very broad amplification lines in the visible and near-infrared regions of the optical spectrum.

In the early 1970's tunable high-pressure CO_2 lasers were put into operation. From the middle 1970's tunable lasers based on color centers in alkali halide crystals—"solid state analogs" of lasers bases on solutions of dyes were undergoing intensive development. Tunable lasers brought about a real revolution in a number of very important fields of optics and experimental physics. This refers first of all to optical spectroscopy (nonlinear spectroscopy is wholly indebted for its achievements to tunable lasers), and to physics and technology of the action of optical radiation on matter. The prospects that were here opened up have for a long time attracted the attention of many research groups to the search for new "wide-band" laser an nonlinear materials, and to the development of tunable lasers in different ranges of the optical spectrum.

It should also be noted that beginning with the 1970's this research and development was also more and more stimulated by the requirements of pico- and femtosecond laser technology: For the amplification and transformation of femtosecond laser pulses materials are needed with truly record-holding bands attaining 10^3 cm^{-1}.

So what is the situation now? Where are the most promising "growth points"? The collective monograph under review is one of the first to answer these questions.

It must be said that its editors, scientists working at the Bell Telephone laboratories (USA), L. Mollenauer and J. White have brought together an international collective of authors who are leading specialists in the field of physics and technology of tunable lasers. Carefully prepared, well illustrated, and provided with a detailed bibliography, the reviews appearing in this book give a clear idea of the present-day new stage in the development of this currently rapidly developing field.

The introductory article written by L. Mollenauer and J. White presents general principles, and examines typical constructions of tunable lasers. Here also a brief discussion is given of methods of mode synchronization in lasers with broad amplification lines, as well as of spectroscopic applications of tunable lasers.[1)]

Chapter 2 "Excimer Lasers" (M. Hutchinson, Imperial College, England) in addition to a by now quite traditional presentation of the principles and diagrams of tunable UV lasers contains new data on powerful wide-band amplifiers based on KrF (with output energies up to 300 J) and on XeCl. Recently such amplifiers have attracted attention as output stages of femtosecond generators of ultraintense light fields.

Chapter 3 "Four-Wave Frequency Mixing in Gases" (C. Vidal, Max-Planck-Institute. FRG) is devoted to nonlinear-optical methods for constructing tunable sources in the UV range of the optical spectrum. The most effective method is the mixing of radiations from tunable lasers in the visible and the near infrared ranges using the cubic nonlinearity of atomic gases; in this way it turns out to be possible to cover the region from 300 to 50 nm. It is noted that in terms of spectral brightness such sources are superior by several orders of magnitude to sources of synchrotron radiation.

In Chapter 4 "Stimulated Raman Scattering" (J. White, Bell Telephone Labs, USA) the principal emphasis is made on combination lasers which for the nonlinear medium utilize molecular hydrogen and different atomic gases.

Although this technique began to be developed already in the 1960's the recent years have brought a number of essential new results. Undoubtedly one of the most important results is the development of antiStokes combination lasers (use is made of the coherent antiStokes radiation from excited states), which enable one to obtain tunable radiation in the UV range. On the whole the material of Chapter 4 is possibly the most complete review of this important problem.

The authors of Chapter 5 "Urea Optical Parametric Oscillator for the Visible and Near Infrared," K. Cheng, M. Rosker, C. Tang (Cornell University, USA) note the new possibilities in the technique of parameteric generators of light associated with the use of oranic nonlinear materials. It must be said that this is only one of the examples of the now clearly expressed new increase in interest in these sources of tunable radiation.

The development of fundamentally new pumping systems based on highly stable YAG-lasers and excimer lasers, the recent successes in producing efficient nonlinear materials—organic crystals, doped crystals of lithium niobate, crystals of potassium—titanyl-phosphate and barium borate—have enabled one to reevaluate the place occupied by parametric generators of light in the technology of generating tunable radiation. At present consideration is being given to producing highly stable pulsed parametric oscillators with line width down to 10^{-2} cm^{-1}, which cover on one crystal the entire visible and near-infrared range.

Chapter 6 "Color Center Lasers", (L. Mollenauer, "Bell Telephone Labs", USA) summarizes the nearly fifteen-year history of the development of these sources. Modern lasers based on color centers in alkali halide crystals have turned out to be particularly effective in the range of 0.8–4 microns. The author of Ch. 6 has achieved pioneering results in the development and applications of such lasers; we recall, in particular, that specifically with the aid of a picosecond laser based on color centers L. Mollenauer and his collaborators had for the first time observed optical solitons.

The relatively short chapter 7 "Fiber Raman Lasers" (C. Lin, "Bell Telephone Labs", USA) is devoted to a very promising and rapidly developing field. The broad lines of Raman scattering in quartz optical fibers enable one to produce efficient combination lasers tunable in the range of 0.3–2 microns.

One can confidently assert that in the very near future such sources will occupy a prominent place in optical experimentation, as generators of tunable femtosecond pulses.

Chapter 8 "Tunable High-Pressure Infrared Lasers" (T. Jaeger, G. Wang, Norwegian Defence Research Establishment, Norway) contains a compilation of data on high-pressure on high-pressure molecular lasers based on Co_2,Cs_2 and N_2O. An increase in the pressure of the mixture to ~ 10 atm leads to overlapping of rotational lines; as a result of this the possibility arises of smooth frequency tuning in relatively narrow ranges of the infrared spectrum.

New experimental data and construction of lasers, utilized in experiments on selective action on polyatomic molecules are presented.

The concluding chapter 9 written by J. Walling (USA) is devoted to a review of the recent achievements in the development of tunable solid-state lasers. It can be stated quite definitely that here, just as in the field of development of parametric generators of light a true "reevaluation" of the possibilities is occurring.

Such outstanding achievements as the construction of a laser based on alexandrite tunable over the range of 710–820 nm, and in particular of a laser based on sapphire with titanium ions, the tuning range of which stretches from 660–1060 nm, radically alters the status of solid-state lasers based on paramagnetic ions within the wide-ranging family of tunable lasers.

The experimental material presented in this chapter shows that now with the aid of tunable solid-state lasers one can cover the range from 660 to 2280 nm. One should not particularly the promising nature of the use of wide-band solid-state materials for the amplification of femtosecond laser pulses; the saturation energies in them attain values of ~ 1 J/cm^2, i.e., the exceed by almost three orders of magnitude the values for excimer amplifiers and amplifiers based on dyes. The latter circumstance is of particular interest for the rapidly developing technique of generating ultraintense light fields, fields with intensities attaining the values of $E \approx 10^{10}$–10^{11} V/cm.

On the whole the book under review gives an impressive picture of the progress in one of the most important fields of present-day laser physics.

Undoubtedly it will be welcomed with interest by specialists involved in the development of tunable lasers, by physicists and engineers involved in work in the field of laser spectroscopy, the physics of selective action of radiation on matter, and by specialists in pico- and femtosecond laser technology.

[1)] We note in connection with this that although the genertion of narrowband tunable radiation with the aid of a dispersive resonator and the productionof ultrashort pulses as the result of synchronization of longitudinal modes are essentially alternative methods for utilizing laser action in media with wide amplification lines, in spectroscopy "the poles draw together". The "time-based spectroscopy" based on the use of ultrashort pulses produces information on the Fourier transforms of susceptibilities measured by the method of "frequency spectroscopy" using narrow band tunable lasers.

Theoretical physics on the personal computer

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E. W. Schmid, G. Spitz, and W. Lösch. *Theoretical Physics on Personal Computer.* Springer-Verlag, Berlin; Heidelberg; New York, 1988. 230 pp.

Until recently the uses of computers in theoretical physics was associated, as rule, with large projects which could be carried out only using large computers and even supercomputers. Computers with a prefix mini- and micro- were relegated to the role of controlling experiments in the laboratory or a low-power calculator for solving simple problems. Such a division is of course conventional and determined to a large extent by the level of development of computing technology.

The computer boom which is not abating already for two decades has given birth to new generations of computers with one of the most significant phenomena of this process being personal computers. Along with the high productivity which sometimes attains the level of productivity of mini- and supermini-computers personal computers now have de-

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