IV International Conference on Atomic and Molecular Pulsed Lasers (AMPL'99)

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In this paper we present a review of most interesting reports presented at the Fourth International Conference on Atomic and Molecular Pulsed Lasers (AMPL'99) held in Tomsk on September 13–17, 1999.

The Fourth International Conference on Atomic and Molecular Pulsed Lasers was held in Tomsk on September 13–17, 1999. The AMPL'99 was organized by the Institute of Atmospheric Optics SB RAS (IAO), Institute of High-Current Electronics SB RAS (IHCE), Tomsk State University (TSU), and Siberian Physical-Technical Institute at Tomsk State University (SPhTI).

The Conference was supported by the Russian Academy of Sciences, Siberian Branch of the Russian Academy of Sciences, Russian State Committee of Higher Education, Russian Foundation for Basic Research, SPIE Russia Chapter, EOARD (Air Force Office of Scientific Research), LEOS/IEEE, Tomsk Center for Innovations, International Center for Fundamental Physics, and Russian Academy of Engineering Sciences.

A total of 129 scientists from Russia, France, USA, Germany, Australia, Belarus, Japan, and Ukraine took part in the Conference. Besides, about 50 students from Tomsk universities made use of the opportunity to listen to reports. In parallel with the Conference, the Professor Prilezhaeva Memorial Readings were organized for students. The invited papers were presented by leading scientists of Russia.

The Conference program was traditional (see, for example, Proc. SPIE **2619**, Atomic and Molecular Pulsed Lasers, ed. by V.F. Tarasenko, G.V. Mayer, and G.G. Petrash (1995); Proc. SPIE **3403**, Atomic and Molecular Pulsed Lasers II, ed. by V.F. Tarasenko, G.V. Mayer, and G.G. Petrash (1997); Atmos. Oceanic Opt. **6**, Nos. 3 and 6 (1993); *ibid* **8**, No. 11 (1995); *ibid* **9**, No. 2 (1996); *ibid* **10**, No. 11 (1997); *ibid* **11**, Nos. 2–3 (1998)). It included the following sections: Gas and Plasma Lasers, Metal-Vapor Lasers, Dye Lasers and Photoprocesses in Complex Organic Molecules, Physical Processes in Gas Lasers, Laser Systems and Applications, Incoherent UV and VUV Sources and Laser Output Conversion. A total of 223 (112 oral and 111 poster) papers were submitted to the Conference. Fifteen most interesting presentations were discussed at the plenary sessions and the Round Table discussion devoted to new applications of lasers.

The Conference was opened with the report on "The History and Prospects of the Metal-Vapor LasersB by Professor G.G. Petrash (Physical Institute RAS, Moscow), who received the heartiest congratulations from the participants on the occasion of his 70th birthday. In the 40-minute report Professor Petrash briefly reviewed the history by illustrating its milestones with the most important results achieved in the development of metal-vapor lasers, recent advances in obtaining high efficiency and repetition rate with the use of copper halogenides, as well as the prospects for application of metal vapor lasers.

The paper "Scaling of Pulsed Molecular Lasers from Nanojoules to Megajoules — A Personal PerspectiveB by V. Hasson (Textron Systems Corporation, USA) attracted particular attention. It presents advances in the development of both miniature molecular lasers pumped by self-maintained discharge with UV preionization and high-power lasers pumped by *e*-beam stabilized discharge.

A. Ulrich with co-authors (Technical University, Munich, Germany and Rutgers University, Newark, USA) in their report "Low-Energy Electron Beam Pumped LasersB for the first time reported on creation of a compact Ar–Xe laser operating at the wavelength of 1.73 μm pumped by low-energy electron beam (10–15 keV), which was injected in the laser chamber through ceramic foil. The lasing was obtained in a quasistationary mode with the radiation pulse 45 μs long at the pulse repetition frequency of 150 Hz. This device allowed simultaneous recording of the laser radiation and the radiation from the excited medium in different spectral regions, including the VUV.

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An interesting report "Effective First-Overtone CO Laser with the Frequency Tuned within the Spectral Range of 2.5–4.2 μmB was presented by A. Ionin on behalf of the group of co-authors (Physical Institute, Moscow, Russia and Air Force Laboratory, USA). The high efficiency and high energy of the output radiation were achieved at the first overtone of CO molecule with pumping by an *e*-beam controlled discharge. The results of CO laser simulation support the feasibility of achieving high efficiency and predicting the conditions needed for this.

In the report on "High-Power Dense Gas Lasers and Spontaneous Emission SourcesB V.F. Tarasenko (IHCE) reviewed the main results obtained during the recent seven years at the Laboratory of Optical Radiation in the development of pulsed dense-gas lasers as well as high-power sources of UV radiation. In particular, XeCl ($\lambda \sim 308$ nm) and KrCl ($\lambda \sim 222$ nm) coaxial excilamps with the mean output power of 200 W were developed. In co-operation with other laboratories of the IHCE, high-power lasers were created with the output energy of 2 kJ at $\lambda = 308$ nm, 200 J at $\lambda \sim 2.8$ μm, 100 J at $\lambda = 249$ nm, 100 J at $\lambda = 1.73$ μm, and 50 J at $\lambda = 2.03$ μm, etc.

The report "Powerful Nuclear-Optical Converters for Application in Scientific Investigations and National EconomyB by A.A. Sinyavskii and V.N. Krivonosov (Federal Nuclear Center, Sarov, Russia) was devoted to projects on the peaceful use of nuclear energy.

The results of research into the photonics of complex organic compounds were generalized in the paper by G.V. Mayer and T.N. Kopylova. T.N. Kopylova presented theoretical and experimental data obtained in this field at Siberian Physical-Technical Institute (Tomsk).

The report on "Kinetics and Spectroscopy of Alkali Rare Gas Ion ExcimersB by Ph. Delaporte et al. (Research Institute of Nonequilibrium Phenomena, University of Pole Sciences, Marseilles, France) summarized the studies of radiation characteristics of ion excimers, which were earlier considered as active molecules of exciplex lasers. However, measurements demonstrated very low efficiency of these ion excimers.

The report on "Improved Power Converter for Pulsed Operation of DVDB by P. Schwarz and W. Heering (Polytechnical Institute, University of Karlsruhe, Germany) attracted particular interest of specialists, who use barrier discharge for excitation of spontaneous emission sources and pumping of new active media. The scheme and parameters of the developed power converter and peculiarities of matching the excitation source and barrier discharge plasma were presented in this report.

B. Lacour in his report "High Average Power HF/DF LasersB (Cilas, Marcoussis, France) presented new results of the studies of non-chain HF and DF lasers pumped by self-maintained discharge in the repetitively pulsed mode. It was shown that using mixtures rich in SF_6, it is possible to create compact laser chambers and volume discharge with very high homogeneity of radiation power distribution over the discharge volume.

The next reports were considered within the framework of the Round Table session. In the report "Excimer Laser DecontaminationB by M. Sentis (Research Institute of Nonequilibrium Phenomena, University of Pole Sciences, Marseilles, France), the problem of decontamination of various surfaces by laser radiation was considered, and some experimental results obtained with the use of XeCl laser were presented.

R. Sze from the Los-Alamos National Laboratory (USA) studied oxygen detection with ArF lasers. This problem originates from glass production industries which require development of remote testing methods.

G.S. Evtushenko (IAO), in his report "Current Applications of Metal-Vapor Lasers in Atmospheric OpticsB gave the examples of metal-vapor lasers application in devices for single- and multifrequency sensing of the atmosphere, UV spectroscopy of atmospheric gases, navigation devices, and in atmospheric adaptive optics. The capabilities of metal-vapor lasers were demonstrated in application to detection of metal layers in the upper atmosphere and to remote sensing of iodine radionuclides in emissions from radiochemical plants.

S.I. Yakovlenko (Institute of General Physics, Moscow, Russia) in his report "On Critical Electron Density in Copper-Vapor LaserB proposed a simple estimate of the limiting electron density at which the generation breaks down because of the lasing levels destruction by electron impact.

V.P. Lopasov (IAO) in the report "On the Feasibility of Laser Generation with Improved Regularity of Photon FluxB proposed a new approach to formation of the inverse state of molecules and generation of the electromagnetic field with large angular momentum $M_p \geq 100\,h$, where h is the Planck's constant.

I.I. Klimovskii (Institute of High Temperatures RAS, Moscow, Russia) presented a paper on "Hydrodynamic Surface Processes Induced by High-Power Laser Radiation and Their Visualization with Laser Brightness Amplifier in Real Time.B The results presented were obtained by him in collaboration with V.G. Prokoshev, D.V. Abramov, and S.Yu. Danilov (State University, Vladimir, Russia). It was shown that a copper-vapor laser monitor allows the processes on the surface of substances exposed to high-power laser radiation to be observed just during the exposure.

V.M. Klimkin (IAO, Tomsk, Russia) in his report "Physics of the Petrash EffectB considered the problems in stability of repetitively pulsed discharges in the mixture of a metal-vapor and a rare gas. He showed that the basic process in physics of repetitively pulsed generation modes is the process of discharge decontraction caused by metal vapor arriving at the active medium. This effect was first used by G.G. Petrash with his colleagues to obtain high output power of metal-vapor lasers.

Below we briefly characterize most interesting oral and poster presentations at different sections.

Section A. Gas and Plasma Lasers

The section was opened by A.A. Ionin, who presented the report "Frequency Tunable Optically Pumped CO Laser.B The results were obtained in co-operation among three research teams: Air Force Research Laboratory (Kirtland, USA), Logicon/RDA (Albuquerque, USA), and Physical Institute RAS, (Moscow, Russia).

V.V. Osipov (Institute of Electrophysics UB RAS, Ekaterinburg, Russia) presented the results of numerical simulations of the CO laser.

The report "New Approach to the Development of High-Power Non-Chain HF/DF Lasers Chemically Initiated by Volume Self-maintained DischargeB presented by K.N. Firsov (Institute of General Physics RAS, Moscow, Russia) attracted particular interest. It was shown in this paper that the conditions for formation of a volume discharge in mixtures with high content of SF_6 differ significantly from those for traditional working mixtures of exciplex and CO_2 lasers. The volume discharge at an enhanced pressure was formed without additional preionization due to special electrode processing applied. The output energy of 400 J obtained in the developed non-chain HF laser pumped by self-maintained discharge is the highest ever obtained for lasers of this type.

V.A. Burtsev (Institute of Electrophysical Instrumentation, St. Petersburg, Russia) in his report thoroughly analyzed nonstationary processes of electron beam interaction with dense gases.

In the report "Amplification of Diffraction Limited Laser Beam in XeCl AmplifiersB by N.G. Ivanov (IHCE, Tomsk, Russia), the conditions for formation of the beam divergence in a two-cascade system with a 25×25 cm exit aperture were studied. After optimization, a 10^{-5} rad divergence of the beam at $\lambda = 308$ nm was achieved.

The interesting report "Influence of Water Vapor Impurities and Gas Temperature on the 1.73 μm Atomic Xenon LasersB was presented by H. Tomizawa and his co-authors (Institute of Technology, Tokyo, Japan; Technical University, Munich, Germany; Rutgers University, Newark, USA). They discovered an additional pulse in the afterglow as the working mixture was heated.

In the report "Dense Gas Lasers Pumped by Inductive Energy Storage GeneratorsB by A.N. Panchenko et al. (IHCE, Tomsk, Russia) it was demonstrated that the use of inductive energy storage with semiconductor opening switches allows creating optimal pump conditions for pulsed lasers in dense gases. High efficiency was achieved using this approach in the non-chain HF laser, TEA CO_2 laser, excimer XeCl laser, and laser at self-limited transitions of molecular nitrogen.

The report "Efficiency of an E-Beam Initiated H_2–SF_6 LaserB by V. Orlovskii et al. (IHCE, Tomsk, Russia) was devoted to the study of the influence of various factors on the efficiency of a non-chain HF laser. Based on the spectral and amplitude-temporal characteristics of radiation, it was confirmed that not only atomic, but also molecular fluoride takes part in formation of the excited HF molecules.

Among poster papers, the papers devoted to the study of lasers of various types should be noted: O. Uteza, Ph. Delaporte, B. Fontaine, M. Sentis, J. Branly, M. Pealat, and M. Makarov "Development of Nanosecond High-Energy Oscillator-Amplifier Excimer Laser SystemB; M. Gastaud and M. Autric "Filtration in an HF Pumped by a Non-chain ReactionB; and M. Sabonnadiere, V.I. Tcheremiskine, Ph. Delaporte, L.D. Mikheev, and M. Sentis "Numerical Modeling of a Photolytically Excited Pulsed Chemical NF_3–H_2 Laser.B

In the paper "Photo-Triggered Non-Chain HF Laser Excited by Self-Initiated Volume DischargeB by V.V. Apollonov, S.Yu. Kazantsev, V.F. Oreshkin, and K.N. Firsov (Institute of General Physics, Moscow, Russia) the design and test results on a high-power HF laser were presented.

A HF laser was also discussed in the report "Energy and Spectral Parameters of Non-Chain HF Laser Pumped by Planar E-Beam and Discharge Initiated by E-BeamB by V.N. Orlovskii, M.V. Erofeev, V.S. Skakun, E.A. Sosnin, and V.F. Tarasenko (IHCE, Tomsk, Russia).

The report "Kinetic and Electrophysical Problems in the Development of VUV Lasers at Rare Gas DimersB by V.A. Burtsev, N.I. Kazachenko, and N.V. Kalinin (Institute of Electrophysical Instrumentation, St. Petersburg, Russia) again placed emphasis on the VUV lasers pumped by an *e*-beam.

CO_2 lasers were considered in the report "Small-Sized CO_2 Lasers with Nanosecond Pulse DurationB by V.M. Orlovskii, A.E. Mendel, and V.A. Panarin (IHCE, Tomsk, Russia) and in the report "CO_2 Laser Excitation by a Combined Discharge Using Gas Flow Through ElectrodesB by V.V. Osipov, M.G. Ivanov, P.B. Smirnov, and V.V. Platonov (Institute of Electrophysics UB RAS, Ekaterinburg, Russia).

A.N. Panchenko, E.H. Baksht, S.E. Kunts, and V.F. Tarasenko (IHCE, Tomsk, Russia) considered formation of long-duration radiation pulses in an electric-discharge XeCl laser.

Section B. Metal Vapor Lasers

This section included 14 oral and 20 poster presentations (seven of them with a three-minute oral presentations). The session was opened with the report "Kinetics of Pulsed Lasers in Metal Compound Vapor and Electronegative Gas AdditionsB presented by G.G. Petrash (Institute of Physics RAS, Moscow, Russia). In this report it was shown that the presence of electronegative molecules (HBr, HCl) in a discharge significantly changes kinetics of the processes which determine the laser output characteristics. Under certain conditions this yields a higher efficiency and power of metal-vapor lasers. The improvement in the

power characteristics of a metal-vapor laser is mostly due to higher pulse repetition frequency. This problem was discussed in several reports.

N.A. Yudin (Institute of Semiconductor Physics SB RAS, Novosibirsk, Russia) in his work made an attempt to experimentally justify the limit of the pulse repetition frequency of metal-vapor lasers. He showed that the presence of an inductance in the discharge circuit results in insufficient heating rate of the pre-pulse electrons. The conditions were determined under which the influence of the pre-pulse concentration of electrons is minimum and further growth of the rate is connected with the processes of relaxation of the lower lasing states.

The processes of stepwise destruction of the upper lasing states can also have some influence. This was shown in the paper "Experimental Observation of the Step Ionization of the $^2P_{2/3,3/2}$ Atomic State of Cu in the CVL Active MediumB by V.M. Klimkin (IAO).

In the report by G.S. Evtushenko et al. (IAO) it was noted that maximum repetition rates (up to 300 kHz), achievable in copper bromide (CuBr) lasers, due to lower energy contribution to the discharge, are higher than those in pure metal vapor lasers. The presentations by A.N. Soldatov and his colleagues (Tomsk State University) and young scientists D.V. Shiyanov and A.V. Pavlinskii (IAO) were also devoted to this problem. The possibilities of obtaining the limiting values of output power and efficiency of metal-vapor lasers were considered in the paper by V.F. Fedorov (IAO).

A particular interest the participants showed in the report presented by R. Mildren (Macquare University, Sidney, Australia). It described the results of studies of the kinetically enhanced metal-vapor lasers and efficient conversion of their radiation into the harmonics in nonlinear crystals to obtain high-power UV radiation.

A.D. Chursin (Istok, Fryazino, Russia) in his report presented the results of the study and development of the sealed-off copper- and gold-vapor lasers with the output power from 1 to 100 W.

The report by E.L. Latush (Rostov State University) was devoted to the development of the effective small-size recombination Sr- and Ca-vapor lasers. The possibilities of pumping metal-vapor by electron beams formed directly in the discharge gap (running away electrons) were demonstrated in the report by G.V. Kolbychev (IAO). A new method for calculating the pressure of saturated metal-vapor was proposed by V.A. Gerasimov (IAO). The interesting results achieved in the study and development of metal-vapor lasers were also reported by V.G. Sokovikov, A.V. Karelin, Yu.P. Polunin, V.N. Kukharev, A.G. Filonov, D.Yu. Shestakov, et al.

Section C. Dye Lasers and Photoprocesses in Complex Organic Molecules

This section is a traditional one in the Conference program. The use of complex organic molecules as active media for lasers strongly needs the study of photoprocesses occurring in complex molecules under the exposure to radiation. In this section much attention was paid to the problems of connections between the electron structure of a compound and its spectral and lasing properties.

The current research in the field of nonlinear optics and spectroscopy shows that the absorbing and emitting properties of molecules change significantly as the intensity of the exciting radiation increases. Photochemical properties of molecules change along with the photophysical properties. Two reports (by R.T. Kuznetsova, and V.A. Svetlichnyi, Tomsk State University) were devoted to the study of photostability and interaction of organic molecules in the excited states depending on the way of formation and deactivation of these states under the action of powerful laser excitation. Using terphenyl derivatives, as an example, it was shown that as the excitation intensity and the operating mode varies, only quantitative composition of the photoproducts generated in the process of phototransformations changed, whereas the qualitative composition remained unchanged. As one of the causes, the authors considered possible population of the highly excited states and two-photon processes. In the report by A.K. Sergeev (Siberian Physical-Technical Institute, Tomsk), particular attention was given to the new technique of determination of the gain coefficient at high-power excitation.

V.A. Chernyavskii (Institute of Atomic and Molecular Physics NASB, Minsk, Belarus) considered the effect of optical anisotropy of solutions under the exposure to laser radiation.

The results of basic and applied research of the photoprocesses in organic molecules under exposure to laser radiation and development of modern laser systems based on them presented by Yu.P. Meshalkin and S.M. Kobtsev (Technical University, State University, Siberian Center for Laser Medicine, Novosibirsk, Russia) provoked an exciting discussion.

The report by Al.A. Zemlyanov (Siberian Physical-Technical Institute, Tomsk, Russia) on laser-induced fluorescence of dyes in droplets attracted particular interest, since new basic knowledge on the peculiarities of molecular emissions in droplets will allow practical application to be found for this phenomenon.

The possibility of calculating populations of excited electronic states of organic molecules (dyes) with the use of calculated and experimental constants of the rate of photoprocesses (V.Ya. Artyukhov, Siberian Physical-Technical Institute, Tomsk, Russia) was discussed. It was shown that if the regime of absorption is nonlinear and the Bouguer law in the integral form does not hold (with the use of high-power pulsed excitation sources), then to interpret correctly the experimental values of the optical transmittance of solutions and to study the population dynamics of electronic states, the proposed scheme of electronic

states should be theoretically calculated and the differential Bouguer law for thin optical layers should be used.

An interesting result obtained in the study of *trans*-stilbene was generation in ethanol and hexane solutions pumped by an excimer XeCl laser (L.G. Samsonova, Siberian Physical-Technical Institute, Tomsk). It was shown that the use of a non-polar solvent and naphtyl derivatives leads to an increase in the quantum yield of fluorescence and efficiency of lasing.

The report by V.V. Maslov (Institute of Radiophysics and Electronics, Kharkov, Ukraine) was devoted the study of spatial-angular characteristics of radiation of lamp pumped by dye lasers under different temperatures of the active element. V.V. Shevchenko from the same institute in his report considered the problem of choosing the parameters and regimes of operation of pulsed xenon lamps and the study of spectral-temporal characteristics at high-power discharge of microsecond duration.

In recent years the interest in solid-state lasers based on organic compounds has essentially increased. Wide promises of the development and design of solid-state lasers emitting in the blue-green spectral region when pumped by a XeCl laser and in the red region by copper vapor laser were demonstrated by T.N. Kopylova (Siberian Physical-Technical Institute, Tomsk). In addition, such media are compact and non-toxic, what makes them more convenient for practical use. These media are an interesting object for solution of one of the fundamental problems in photophysics, namely, the development of methods for control over energy conversion processes. The paper by V.I. Yuzhakov (Moscow State University) was devoted to the purposeful synthesis of polymer bifluorophores, which enable the selective process of exchange of electron excitation energy between solid-sate and liquid media.

Papers devoted to photophysics and photochemistry of phenols became the subject of wide discussions at the Conference. Since transformations occurring in water media with pollutants under exposure to UV radiation are very complicated, it is necessary to analyze and monitor these phenomena. In the review presented by I.V. Sokolov (Siberian Physical-Technical Institute, Tomsk), the emphasis was placed on the photochemical methods for solution of problems in the ecology of the hydrosphere. The particular attention was paid to phenols being among the most abundant environmental pollutants all over the world. O.K. Bazyl (Siberian Physical-Technical Institute, Tomsk) in her report considered the influence of complex formation on the photolysis of phenol and its chlorine substitutions using the methods of quantum chemistry. She concluded that the experimentally observed dependence of the quantum yield of fluorescence of water solutions of phenol results from increasing probability of the photobreak of the OH-bond with increasing excitation energy. Yu.P. Morozova (Tomsk State University) considered the influence of the acceptor capability of mixed solvents on the fluorescent properties of phenol.

In some papers the quantum-chemistry calculations of spectral-luminescent properties of organic compounds were presented. V.Ya. Artyukhov in his paper concluded that the experimental fluorescent characteristics of organic compounds including the styryl group (C–C=C–C) corresponds to the reaction of photoisomerization through the linear construction of this group ("butadieneB model). N.Yu. Vasil'eva (Siberian Physical-Technical Institute, Tomsk) theoretically considered the aspects of influence of changes in the geometry of the excited state on the spectral characteristics of *para*-terphenyl derivatives.

Young scientists, postgraduate and undergraduate students of the Physical, Radiophysical, and Chemical Departments of the Tomsk State University took an active part in this section.

Section D. Physical Processes in Gas Lasers

This section covered a wide scope of problems in physics of active media. Most important among them are the following:

– mechanism of formation of population inversion;
– optimization of active media;
– enhancement of the efficiency of gas and plasma lasers.

Thirty four (12 oral and 22 poster) reports were presented at this section.

Two invited papers prepared by scientists from the Yakovlenko scientific school (Institute of General Physics RAS, Moscow, Russia) were presented among the first ones. The report by S.I. Yakovlenko and A.M. Boichenko reviewed the studies of kinetics of active media of excimer plasma lasers. Potentialities of excimer laser are now far from being exhausted. The detailed analysis of their active media allows also a number of key problems in physics of the exciplex lasers to be solved. The report by A.V. Karelin and V.V. Porkhaev was devoted to the problem of the development of nuclear pumped lasers. New carbon, oxygen, nitrogen, and chlorine lasers were proposed.

Yu.I. Bychkov, S.L. Gorchakov, and A.Ya. Yastremskii presented one oral and two poster papers devoted to volume electric discharge in gas mixtures including SF_6. The research was performed in the Laboratory of Gas Lasers of the Institute of High-Current Electronics SB RAS, Tomsk. The results of theoretical and experimental studies of electric discharge in elegas, as well as in mixtures of SF_6 with H_2 and C_6H_{14} were presented.

It was found that the spatial inhomogeneity of a volume plasma column is formed at the initial stage of the discharge formation. The relative homogeneity depends on the density of cathode spots. Thus, at the spot density ≈ 20 cm^{-2}, overlapping of the diffuse plumes provides for good volume homogeneity of the plasma. The maximum current density at a good

homogeneity was 700 A/cm^2. In these papers, the model of evolution of the plasma channel was proposed, numerical calculations performed, and physical processes influencing the evolution of the plasma channels were considered.

K.N. Firsov in co-authorship with V.V. Appolonov, S.Yu. Kazantsev, and A.V. Saifulin (Institute of General Physics RAS, Moscow) presented a new study of self-induced volume discharge in mixtures of SF_6 with hydrocarbons for excitation of non-chain HF/DF lasers.

In the paper "E-Beam Formed Plasma. Lasers and TechnologiesB by A.M. Yancharina (Siberian Physical-Technical Institute), the unique properties of recombination-nonequilibrium plasma excited by low-energy (2–10 keV) *e*-beam formed in the electric discharge were discussed. The characteristics of active media based on mixtures of rare and molecular gases were presented, as well as the parameters of Penning helium and neon atomic plasma lasers. The possibility was shown of obtaining generation at some new atomic transitions in helium. The prospects of using plasma for technologies were considered.

In the paper by I.I. Klimovskii and V.A. Shcheglov (Institute of High Temperatures RAS, Moscow) the well justified prognosis was presented for the possibility of creating a new class of lasers operating on the repulsive terms of dissociable diatomic molecules.

A.R. Sorokin (Institute of Semiconductor Physics SB RAS, Novosibirsk) discussed the promises of the use of open discharge for pumping gas lasers. An important feature of this discharge is the possibility of achieving high (~ 50 A/cm^2) current densities of *e*-beams with the electron energies about several keV in short (~ 10 ns) pulses.

T.M. Gorbunova (Tomsk State University) presented her study of ionization waves of the potential gradient at the breakdown of long discharge gaps, which are used in metal-vapor lasers, by nanosecond pulses. It was found that superluminescence at $\lambda = 510$ and 570 nm in the active medium of a copper-vapor laser operating in the self-heating mode has a pronounced time structure comparable with the nonmonotonic structure of the current pulse characteristic of the wave breakdown.

Interesting studies were presented in two reports by Yu.A. Tolmachev (St. Petersburg State University). In one of the reports he and Yu.A. Piotrovskii discussed the possibility of appearance of superluminescence in the solar atmosphere. Experimental evidences were given of anomalous intensification of the Sun glow in some spectral regions. These anomalies were interpreted as the result of intensification of spontaneous emission at HeII lines in the medium with inverse population. The authors suggested the following cause of the inversion: contact of the hot plasma (T about 1 000 000 K) with relatively cold layers of the atmosphere. The charge exchange between doubly charged helium ions and hydrogen atoms was considered as the main process of selective excitation.

M.K. Lebedev and Yu.A. Tolmachev in the presentation devoted to diffraction of ultrashort radiation pulse stated the problem of analyzing the diffraction of a delta-shaped perturbation on two typical diaphragms: a narrow slit and a round opening. The proofs were presented that the system response consists of two components: the field of a passed wave and of the wave scattered by opening edges. The Fourier transforms of the obtained solutions are asymptotically transformed into the known equations for monochromatic waves.

The presentation by E.P. Skorokhod with co-authors (Moscow Aviation Institute) was devoted to the distribution of excited atoms in nonequilibrium plasma of rare gases. A set of nonlinear equations was solved numerically, and the phase diagrams of meta-equilibrium states of Ar, Kr, and Xe were obtained. The characteristic distributions of the excited states of stationary argon plasma were presented, as well as the experimental distributions of yttrium excited states obtained under conditions of erosive plasma jet of high-current discharge in a capillary tube (Y_2O_3).

V.P. Dyomkin, O.G. Revinskaya (Tomsk State University), and L.V. Gorchakov (Tomsk State Teacher-Training University) studied the influence of the collisional electron excitation on the spectral line profile and presented new data on absolute line strengths obtained in the Coulomb approximation.

Very interesting experimental data were presented by A.A. Chernenko (Institute of Semiconductor Physics SB RAS, Novosibirsk). He observed population inversion in transitions of some HeI and HeII levels in the buffer zone of a high-power capillary discharge. The possibility of using this plasma to create active media for VUV lasers was also discussed.

In the paper by V.A. Churikov (Tomsk State Teacher-Training University), possible isomers for creation of gamma lasers were considered, and some new isomers proposed.

Section E. Laser Systems and Applications

The total of 15 oral and 20 poster papers were presented at this section. The papers covered rather wide scope of topics, among them there are the problems of creation of new lasers for medicine, laser separation of isotopes, remote sensing of atmospheric parameters, laser navigation systems, laser television, etc. Several papers were devoted to the study of new effects accompanying the use of high-power laser radiation.

The session was opened with the paper on "Electron Plasma Component-Controlled MVL System.B This paper presented a review of the methods and devices allowing, on the one hand, optimization of the lasing characteristics and, on the other hand, fast control of the main output parameters: energy, power, pulse repetition frequency, radiation chromaticity, etc. New technical approaches to control over output parameters

allowed the record characteristics to be achieved in the specific output power (2 W/cm^3 at the discharge tube diameter of 4–6 mm and 0.2–0.3 W/cm^3 at the diameter of 25–35 mm) at the pulse repetition rate of 150–270 kHz in a metal-vapor laser; the efficiency as high as 9% was obtained in a copper-vapor laser. Newly developed systems based on metal-vapor lasers and dye lasers intended for medicine, laser light graphics, etc. were presented in this paper as well.

One of the peculiarities of Tomsk conference is a large number of papers devoted to the study and applications of metal-vapor lasers (MVL's). This conference was not an exclusion; more than 10 papers were devoted to medical applications of MVL's. It is worth noting, among them, the papers by V.A. Evtushenko (Scientific Research Institute of Oncology of the Russian Academy of Medical Sciences, Tomsk) devoted to application of low-intensity laser therapy for treatment malignant tumors in children, in complex rehabilitation treatment of patients operated on stomach and patients with chronic lung diseases, etc. It should be noted that the new methods of treatment are being continuously developed in these works and, on the other hand, the statistics is collected on already developed methods as far as concerned their efficiency in treatment of patients. A total of more than two thousand patients have been treated with the laser therapy at Tomsk Scientific Research Institute of Oncology.

Among the researches on laser application in medicine, the papers by E.P. Gordov (IAO) and E.D. Melchenko (Institute of Health Resorts RAMS) should be noted. In the former paper devoted to revasculation of myocardium, it was proposed to use a Nd:YAG laser, which proved to be more promising for these purposes than high-power CO_2 lasers. In this study a more intense growth of the capillary system in the vicinity of new channels was experimentally shown to occur.

Interesting results were presented in the three papers by S.M. Koptsev (Novosibirsk State University) devoted to the study of the titanium-sapphire laser spectrometer pumped by the Ar^+ laser and the single-frequency laser system pumped by a copper-vapor laser and intended for laser separation of isotopes. The works on the titanium-sapphire laser spectrometer continued the earlier research in the development of a femtosecond spectrometer, but the second paper presented absolutely new experiments on creation of a high-power laser system "dye + MVLB with the total power of 15–29 W on several lines with the pump power of the copper-vapor laser of 60–80 W.

One of the problems that are widely discussed in connection with the creation of laser TV-sets with a large screen is the problem of high-efficiency generation in the blue spectral region. In the paper by M.A. Kazaryan (Physical Institute RAS, Moscow), new results were presented on lasing at $\lambda = 450$ nm by nonlinear conversion into the second harmonic of a titanium-sapphire emission pumped by a copper-vapor laser with a commercially available active element produced at Istok Company.

Several presentations were devoted to laser applications to environmental studies. V.D. Burlakov (IAO) presented new results on cloud sensing with the use of a copper-vapor laser. A.N. Malov (Institute of Laser Physics SB RAS, Novosibirsk) presented a high-power tunable TEA CO_2-laser for a differential absorption lidar operating in the IR region.

Besides, the results on laser guidance methods for vehicles (G.A. Kaloshin, IAO), spectroscopic software for laser diagnostics of heated CO, CO_2, and H_2O gases (O.K. Voitsekhovskaya, Tomsk State University), on the mechanism of degradation of GaAs surface under exposure to UV laser radiation, as well as on designing particular laser systems were presented. New results presented at the section demonstrated the advances achieved in the development of laser applications in the fields adjacent to laser physics.

Section F. Sources of Incoherent UV and VUV Radiation and Laser Output Conversion

The results obtained by five research groups from Germany, France, and Russia within the framework of the INTAS–96–351 projects were discussed at this section. The main research task of the project was to study the nature of the third continuum radiation in rare gases.

In the paper "Comparative Analysis of Molecular Ion Continua of Pulsed X-Ray Radiation, E-Beam, or Ion Beam-Excited Rare GasesB by E. Robert, C. Cachoncile, J.M. Pouvesle (France), A. Fedenev, V. Tarasenko (Russia), J. Wieser, and A. Ulrich (Germany), it was shown that the third continua consist of a great number of bands, the conditions for appearance of which depend on the gas pressure and do not depend on the method of pumping with a hard ionizer.

A.M. Boichenko and his co-authors (Institute of General Physics RAS, Moscow; Institute of High-Current Electronics SB RAS, Tomsk) in their paper on "Nature of the Third Continua in Inert GasesB presented detailed analysis of the main processes influencing the formation and emission of singly and doubly charged molecular ions and showed that at an enhanced pressure (~1 atm and higher) the singly charged molecular ions produce the main contribution to the third continuum radiation in the UV spectral region.

In the paper "Novel Pathways to the Third Inert Gas Excimer Continua ExplorationB by J. Wieser, M. Salvermoser, A. Ulrich, and A. Fedenev (Technical University, Munich, Germany; IHCE, Tomsk, Russia), the dynamics of the third continuum radiation within separate bands was presented for different time intervals in the case of pumping by a pulsed ion beam of nanosecond duration, and the positions of separate overlapping bands were determined. The assumption

was put forward that molecular ions yielding radiation in the third continuum are mostly formed with the participation of a doubly charged rare gas ions.

The energy emitted in the third continua of xenon and krypton was measured in the study by A.V. Fedenev and V.F. Tarasenko (IHCE, Tomsk). In the paper "The Third Continua Radiation Efficiency in Inert GasesB presented by A.V. Fedenev it was shown that at an *e*-beam pumping, the fraction of energy emitted into the third continua during the *e*-beam action and in the near afterglow is less than 0.5% of the *e*-beam energy pumped into the gas.

The paper "Wide-Band UV Radiation in Ne under E-beam or Discharge ExcitationB by M.I. Lomaev with co-authors (IHCE, Tomsk) presented the results of experimental studies of amplitude-temporal and spectral characteristics of a broadband radiation of neon within the bands of 200 to 500 nm wide. It was shown that a new band appeared in the longwave spectral region as the pressure increased. As the pressure increased from 1 to 5 atm, the radiation intensity within this band increased roughly by five times.

The group of French scientists (B. Lacour et al.) studied UV emission of argon jets in the ambient air excited by a pulsed X-ray radiation.

The paper "The Third Continuum in Ar and Kr Excited by E-beam and E-beam Initiated DischargeB by A.V. Fedenev, V.S. Skakun, and V.F. Tarasenko (IHCE, Tomsk) was devoted to the study of influence of the electric field on the intensity and spectrum of the third continua radiation.

One more topic that was discussed at this section was sources of spontaneous emission operating in different spectral regions. These sources are pumped with various types of discharge. Thus, particular interest was shown in the study on "Incoherent Red Light Source Development for Photodynamic TherapyB presented by R. Sze (National Laboratory, Los-Alamos, USA). This paper presented interesting results on obtaining high-power spontaneous emission in neon at elevated pressure and in mixtures of rare gases with alkali metals.

G. Zvereva (S.I. Vavilov State Optical Institute, St. Petersburg) presented her results on simulation of the barrier discharge in xenon.

In the paper "Comparison of Excitation Methods for Xe Excimer Barrier Discharge LampsB by R. Mildren (Macquare University, Australia) it was experimentally shown that the xenon dimer emission efficiency increases markedly with the use of short pump pulses.

A lot of results on sources of spontaneous emission was presented in papers presented by scientists from the Institute of High-Current Electronics (Tomsk): M.I. Lomaev et al. "High-Power Short Pulse Duration UV Sources,B M.V. Erofeev et al. "Lifetime of Working Mixture in XeCl and KrCl Excilamps,B as well as in the papers prepared in co-operation with other laboratories of Russia (Institute of General Physics, Moscow): A.M. Boichenko, V.S. Skakun, E.A. Sosnin, V.F. Tarasenko, and S.I. Yakovlenko "KrCl and XeCl Excilamps Radiating in a Barrier DischargeB and the USA (National Laboratory, Livermore, USA): M.I. Lomaev et al. "UV Sources and Application for Radical Oxidation and Direct Photolysis in Water.B

Reports devoted to laser radiation conversion in various media attracted much attention as well. It is worth noting the papers prepared at the Institute of Optical Monitoring SB RAS (Tomsk). They considered the study, creation, and use of crystals for conversion of laser radiation: A.I. Gribenyukov, G.A. Verozubova, and V.V. Korotkova "Melt Composition and Optical Transparency of $ZnGeP_2$,B A.I. Gribenyukov, G.A. Verozubova, V.V. Korotkova, Yu.F. Ivanov, and Yu.P. Mironov "Structure Defects in $Cd_{0.75}Mn_{0.25}Te$ Solid Solution,B Yu.M. Andreev, V.V. Badikov, A.V. Vernik, P.P. Geiko, A.I. Gusamov, and V.M. Petrov "Pulsed CO_2 Laser frequency Doubling in a New Nonlinear $AgGa_xIn_{1-x}Se_2$ Crystal,B and Yu.M. Andreev, V.G. Voevodin, P.P. Geiko, A.I. Gusamov, and V.M. Petrov "AP-Conversion of CO_2 Laser Signals.B

An interesting material was presented by F.T. Kokh, N.G. Kononova, A.M. Yurkin, E.G. Samoilova, and T.A. Lisova from the Institute of Mineralogy and Petrography RAS, Novosibirsk, Russia. It was devoted to "Development of Nonlinear Optical BBO and CLBO Crystals for Laser Conversion: Crystal Growth under Distributed Heating Conditions in a Growth Crucible.B

N.G. Ivanov, V.F. Losev, and V.F. Prokop'ev (IHCE, Tomsk) in the paper on "Stimulated Rotational and Vibrational Raman Conversion of High-Quality XeCl Laser Beam in HydrogenB studied conversion of a highly coherent XeCl laser beam in hydrogen. Stokes beams with a limiting divergence (close to the diffraction limit) and the line width of 0.01 cm^{-1} were obtained. The photon efficiency of the pump radiation conversion to the first Stokes component was 95%.

The papers by V.N. Ivanov and A.M. Lasitsa (Omsk State Technical University) described generation of laser radiation harmonics in a shock wave by an ensemble of three-level atoms and influence of sonic and low-frequency electromagnetic waves propagating in a substance on the spectral composition of the scattered laser radiation.

The papers presented at the Conference have been published in the topical issues of SPIE (2000) and *Atmospheric and Oceanic Optics* [No. 11 (1999) and No. 3 (2000)], and in *Kvant. Elektron.* (*Russian Quantum Electronics*).

At the session of the Organizing Committee, which took place on October 7, 1999, it was decided to hold the next Vth International Conference on Atomic and Molecular Pulsed Lasers (AMPL'01) in September 2001 in Tomsk.