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S. Hibben, et al

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SOVRaD

A Digest of Recent Soviet R & D Articles

CONTENTS

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Holographic Imaging
Nuclear pumped laser

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This is a collection of brief abstracts on miscellaneous topics from the current Soviet technical literature. The intent is to supply a quick look at items of possible interest, including topics not necessarily named in the DARPA interest profile, as a supplement to our reportage on specified topics.

It is intended to publish this collection on a monthly basis, to continue to provide prompt coverage of numerous aspects of Soviet R&D. As an added feature, all recently acquired books will be listed as they are received. A list of source abbreviations is appended.

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INTRODUCTION

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For further information the reader is invited to call Stuart Hibben or Lee Boylan at Informatics on (301)-770-3000.

Fission-To-Optical Energy Conversion (abstract)

The authors discuss the concept of converting nuclear fission energy directly into optical rather than thermal energy as is done in the standard reactor. They postulate a fission-pumped laser in which fission energy would be used to generate an active medium directly, for amplifying e-m radiation. The conversion is seen in two stages: (1) A relaxation stage in the reactor's moderating medium, characterized by a recombination nonequilibrium and (2) radiation amplification in the recombination medium.

The model assumes a gaseous form of uranium, e.g. UF_6. The U^{235} fission products include multiply-charged ions, with a large portion of energy $W_0 = 162$ Mev going into the ionization process. The free electrons are cooled on contact with the gas and then recombine; hence in such a gas phase reactor a highly recombinative nonequilibrium plasma is formed which under correct conditions can undergo population inversion of certain bound electron states. The realizable gain would be enough that a laser of not over 10 meters in length should be feasible.

Using the example of UF_6 and helium as a filler gas, the authors calculate that 10^{13} fission events/cm^3/sec would be required. This is a demanding figure for a gas phase reactor, but might be obtained if pumping is done in a fast pulsed mode. [Gudzenko, L. I., and S. I. Yakovlenko. Atomic laser-reactor. KSpF, no. 2, 1974, 14-15].

X-ray Laser Theory (abstract)

The author, who is studying the theoretical possibilities of extremely short wavelength lasers, here suggests a feasible mechanism for exciting the lowest nuclear levels required for lasing in the x-ray band. A recoilless method for generating the necessary intense narrow x-ray lines for such lasing was proposed by Khokhlov (ZhETF P, v. 15, no. 9, 1972, 580), based on the use of crystals containing long-lived nuclear isomers.

Letokhov suggests excitation of the laser nuclear levels by x-ray pulses from a high-temperature laser plasma, based on coincidence of ion emission lines and lines of the characteristic atomic spectra having resonant nuclear transitions in the 1 to 100 kev range. Both two- and three-level systems of pumping nuclear levels are considered, with the three-level system the more efficient in pumping long-lived nuclear isomers. Optimum conditions for the three-level system would require a pump density on the order of 10^{11} photon/cm^2/sec/Hz, which could be achieved by narrowing the pump pulse to 10^{-12} sec. [Letokhov, V. S. Pumping of nuclear levels by x-rays from a laser plasma. Kvantovaya elektronika, no. 4(16), 1973, 125-127].

Oscillation Instability in the Orotron (abstract)

The orotron is one of several experimental configurations of open microwave resonators, developed in recent years by the authors and other Soviet researchers. The pioneer work in this type of design has been done in P. L. Kapitsa's laboratory and has appeared in numerous articles in the series Elektronika bol'shikh moshchnostey (High power electronics).

The present article reviews calculations on the technical instability of an orotron operating in the shortwave millimeter range. Instability is mainly due to variations in supply voltage and in cathode emission current. It is shown that for a relative instability of 10^{-4} in voltage and 10^{-2} in emission current, relative oscillation frequency instability would be 10^{-6}, which is an order of magnitude better than existing microwave devices in the same frequency range. [Kostromin, V. P., and F. S. Rusin. Instability of oscillation in an orotron. IN: Tr. VNII fiz.-tekhn. i radiotekhn. izmereniy, no. 13, 1973, 104-108. (RZhF, 6/74, no. 6Zh273)].

Power Through Gas Lines (abstract)

The first experimental 220 kV line for power transmission by gas conduit is reported operational over a 200 m distance. The line was designed and built by the Scientific Research Institute of Power Supply System, Northwestern Section, and the Hydroelectric Installations Trust. According to N. Tikhodeyev, Chief of the Laboratory of High-Voltage Techniques, the transmitting capacity of the so-called gas line is several times that of the usual high-voltage cable. The line uses two concentric metal pipes, the internal pipe serving as the conductor. Sulfur hexafluoride gas is pumped constantly under high pressure into the annular space between the two pipes through perforations in porcelain partitions spaced at 2.5 m intervals inside the larger tube. According to preliminary cost figures, substitution of the new line for the existing cable power supply system in a city the size of Leningrad would result in tens of millions rubles savings. [Gerasimov, V. Tubular power transmission line. Sots. industriya, Jan. 23, 1974, 4].

Surface Explosion With an E-beam (abstract)

The authors consider the case of powerful e-beam interaction with a metal surface, in which beam density is sufficient to generate a surface explosion. It is shown that at sufficiently high beam currents a temperature instability arises as a result of heat accumulation in the metal interaction zone. Using a spherical model of a conductor with current source at $r = 0$, the authors develop analytical expressions for the explosion threshold value of current, development time of the process, and the radial range in the

conductor in which an exponential rise of temperature can be expected. [Namitokov, K. K., and V. B. Krasovitskiy. Thermal explosion from electron beam focusing on a metal surface. FiKhOM, no. 1, 1974, 10-13].

E-Beam Ablation of Metal (abstract)

The authors, who have published a number of papers on high-power laser effects on metals, here examine the analogous damage effects from a high current electron beam. Seventeen types of metals were subjected to pulsed e-beam discharges of 10 ka peak amplitude and duration on the order of 100 μsec. Data recorded included vaporization time, ejecta mass, and crater dimensions in the target metal. Results show that for all metals studied except for Cu, Al, and Mn, the ejected mass and the damaged surface area are directly proportional to atomic weight and thermal diffusivity, respectivcly; crater depth is inversely proportional to metal melting point.

The authors conclude that a two-stage ablation process occurs: a stationary step of progressive heating to melt, and a dynamic step of ejection of liquid metal drops and solid particles. Thus, the first step involves a thermal mechanism and the second an explosive erosion of the superheated liquid metal, analogous to a laser beam effect. [Ageyev, V. A. and M. A. Sultanov. Ablation mechanism of metal from supersonic plasma flares, as a function of thermal conductivity. TVT, no. 1, 1974, 17-23].

E-Beam Destruction of Solids (verbatim)

Brittle failure was studied of solids (metals, semiconductors, ionic crystals, glasses) exposed to powerful electron beam pulses with durations of 20-40 nsec and average particle energy of 0.3 and 3 MeV. It is assumed that the transmission of almost all energy directly to the electron subsystem of the crystal, and subsequently to the lattice, results in the formation of shock waves which are responsible for destruction. The material strength determined from irradiation by intensive electron beams is taken to be the limit strength. [Gering, G. T., and A. N. Valyayev. Razrusheniye tverdykh tel moshchnymi impul'snymi puchkami elektronov (Destruction of solids by powerful pulsed electron beams). Tomsk. politekhn. in-t. Tomsk, 1974, (RZhF, 6/74, no. 6Ye871 DYeP)].

Nanosecond Flashlamp (verbatim)

Results are given of the development of the contactron, a mercury lamp designed for generation of nanosecond light pulses. Light pulse energy with a duration of 30 nsec is up to 8×10^{-11} j. The contactron is housed in a 30 x 60 mm glass envelope, dimensions which allow it to be used directly in type G5-12 (GKI-46) generators without any alteration of the latter. [Zaretskas, V. S., and Z. H. M. Ronkin. A new source of nanosecond light pulses. IN: Impul's. fotometriya, L., Mashinostroyeniye, no. 3, 1973, 143-146 (RZhF, 5/74, no. 5D1040)].

Direct Imaging On Glass (abstract)

A brief interview with B. T. Kolomiyets of the Ioffe Physicotechnical Institute discusses recent findings on properties of chalcogenide glass. In addition to their semiconducting properties, certain of these show a highly sensitive internal photoeffect as well as optical imaging properties without any chemical processing. Workers at the Ioffe and other collaborating institutes foresee some interesting applications of chalcogenides in high resolution holography and semiconductor photography. [Photos on "glass". Sovetskaya Rossiya, April 23, 1974, p. 4].

Superconducting Antenna (verbatim)

Theoretical and experimental studies are reported on a small superconducting antenna designed by the authors, and consisting of an elementary radiator and a section for matching to the transmission line. It is shown how antenna effectiveness is increased by going to the superconducting state. Particular attention is devoted to the problem of matching the antenna to the transmission line. From comparison of theoretical and experimental data an operational characteristics, the authors establish the usable theoretical limits of the design. An evaluation is made of the maximum power that can be radiated without losing the superconducting state. Several examples are suggested for possible application of devices of this type. [Krivosheyev, Ye. F., M. A. Martynov, and V. A. Pavlyuk. Small superconducting antenna. IN: Tr. Fiz-tekhn. inst. nizk. temperatur, AN UkrSSR, no. 28, 1973, 103-103 (RZhF, 7/74, no. 7Zh366)].

Holographic Movies (abstract)

The author reviews holographic imaging techniques and discusses their possible application to three-dimensional motion pictures. Advantages of a holographic motion picture are noted, in comparison to the present day stereoscopic motion picture. The probability of developing a cartridge type holographic movie projector for home use and, ultimately, for individual viewing is rated very high by Denisyuk. The first step toward realization of such projector would be development of a special screen, possibly using a mirror. Diagrams of possible image recording and projection with the help of a mirror screen are presented.

Other technical problems in the way of development of a holographic motion picture are discussed. The most important still unsolved problems are development of techniques of hologram miniaturization, without reducing dimensions of the screen and the viewing window, and of three-dimensional hologram synthesis from conventional photographs of small

hologram areas. The most promising solution to the first problem is believed to be introducing of a diffusion screen proposed by Haines. (Proc. IEEE, v. 55, 1967, 1512). Denisyuk notes that the new technique would require other special design efforts in laser type, photosensitive medium, and recording and reproduction of the sound track; but none of these are seen as insurmountable. [Denisyuk, Yu. N. Perspective and problems of holographic motion pictures. ZhTF, no. 12, 1973, 2457-2462].

Synthetic Aperture Holography (verbatim)

It is shown that a synthetic aperture radar can be regarded as a holographic system, i. e. a system for registering a wave front and its consequent reconstruction by an optical method. In the process, the image planes with respect to range and azimuth do not coincide, as the range and azimuth scale factors are not identical. Therefore it is necessary to use a special optical system with conical, cylindrical or spherical lenses. An analysis of these systems points to the advantages of anamorphotic telescopic optics with cylindrical lenses. [Nemtinov, V. B., and O. V. Rozhkov. Optical methods of reconstructing a wave front recorded in the r-f band by means of a synthetic aperture radar. IN: Tr. Mosk. vyssh. tekhn. uch-shcha im. N. E. Baumana, no. 174, 1974. (RZhRadiot, 7/74, no. 7G7)].

Synthetic Aperture Interferometer (abstract)

In long baseline radio interferometry the technique of moving one receiver over a series of fixed distances has been advanced as a means of minimizing the inherent angular dissimilarity of the two receivers. In a theoretical treatment the authors here extend this idea to the logical limit of continuous motion of one receiver, acting as a synthetic aperture, so that the angular discrepancy disappears. With earth rotation providing one coordinate motion, the remaining orthogonal motion is achieved by arbitrarily extended movement of the receiver along a track. The limit possibilities of this approach are examined in terms of statistical properties of signal and noise (source and receiver), their relative amplitudes, observation time, and motion trajectory parameters. An example is given illustrating determination of the required trajectory moments for an assumed point source located at the zenith and at some arbitrary range. [Sazonov, V. V., and V. V. Karavayev. Theory of using a synthetic aperture interferometer to measure the position of an r-f noise source. IVUZ Radiofiz, no. 12, 1973, 1861-1866].

Bragg Echo: A New Effect (verbatim)

A new phenomenon is predicted which would appear as the lack of coincidence between propagation direction of exciting radiation pulse and that of the coherent response, in periodic structures. This phenomenon arises from interference of secondary radiation. In crystals the phenomenon would be

detectable only in the x-ray range ($\lambda < 10$ Å) at an excitation pulse width = 10^{-13} sec, which would be possible only in the case of an x-ray laser. It is suggested that the phenomenon be named the Bragg echo. The method of Bragg γ echo is proposed for studying relaxation processes in nuclei in the case of small specimen quantities. It is shown that one could detect time motion of nuclear spins by observing the time differential function of angular γ-γ correlation. [Buyev, A. R., U. Kh. Kopvillem, and L. N. Shakhmuratova. Gamma echo, Bragg echo, and appearance of echo signals in the correlation characteristics of nuclear radiation. IN: Uch. zap. Kazan. ped. in-t. no. 125, 1973, 60-65. (RZhF, 5/74, no. 5D867)].

High Pressure Configuration (abstract)

A brief theoretical analysis is given of the superhigh pressure press proposed by Naoto (J. Japan High Pressure Inst., 9, 3, 1971). The original presentation suggested a spherical configuration of pyramidal elements, but did not describe the operational principal. The authors here analyze the pressure theoretically obtainable by uniform spherical compression of the pyramid elements, so that an arbitrarily high pressure is generated at their common apex. The claims made for the Japanese design are judged somewhat exaggerated, however, since the specimen volume becomes exceedingly small as pressure increases; for example the 2 megabars claimed would apply to a specimen radius not over 10^{-5} mm. [Zababakhin, Ye. I., and I. Ye. Zababakhin. On a super-high pressure press. ZhPMTF, no. 3, 1974, 116-120].

New Heavy Current Pulse Generator (abstract)

Specifications and operating data are given on the "Vodyanoy" pulse generator, a recent design of the Siberian Branch of the Institute of Nuclear Physics for their program on electron heating of plasma. The design features a high level of isolation of the driver transformer and pulse forming network, obtained by using ultrapure water under 100 atm. pressure; with this dielectric a resistivity of 20 Mohm x cm is achieved. The gun has registered 110 ka current pulses of about 40 ns duration, at a discharge voltage of 1 Mv. In the initial design the titanium foil anode tended to degrade rapidly owing to self-compression of the electron beam in transit from the cathode; this was substantially reduced by applying an axial magnetic field to the interelectrode space to counteract beam compression. Tests so far show that a pulse power on the order of 10^{11} watts has been developed. [Boyarintsev, E. L., V. A. Kapitonov, and V. A. Kornilov. The "Vodyanoy" - a powerful relativistic electron beam generator. DAN SSSR, v. 217, no. 4, 1974, 808-811].

Magnetic Effects on Water (abstract)

A brief resume of a deposited paper describes some effects of a magnetic field on water. Results indicate that water density is altered by change in dipole moment of water molecules, caused by the applied field. Data include the corresponding change in water surface tension from an applied field, measured over a 30-90° C water temperature range. [Lychagin, N. I. Altered physical properties of water in a magnetic field. IVUZ Fiz, no. 9, 1974, 159].

Holographic "sonovision" (verbatim)

Advantages of holographic "sonovision" over ordinary "sonovision" are discussed. Difficulties are discussed which occur in r-f holographic systems designed for medico-biological studies or for defectoscopy. One obstacle to practical application is the difficulty in obtaining an object image in real time using the standard two-step holographic process. A block diagram is given and a method explained for direct reconstruction of an object image, from diffraction of coherent light on wavefronts of a supersonic field scattered by the object. Parameters of the device are given, together with theoretical and experimental sensitivity. [Mironov, B. S., and A. A. Perren. Experimental device for holographic "sonovision" in real time. Izv. Leningr. elektrotekhn. in ta, no. 145, 1974, 36-43. (RZhF, 8/74, no. 8Zh837)].

Optical Penetration of Sea Surface (abstract)

The case is considered of illuminance E in an underwater medium as a function of optical depth τ and probability of photon release, Λ. The upper bound of the water is assumed illuminated with a collimated light beam of arbitrarily large diameter. Usually analyses of this type are concerned with maximum illumination depth; the authors however assert that the region near the surface (τ = 1--10) is also of interest and has been neglected in the literature. They develop semiempirical formulas for E/E_0 as functions of τ and Λ, where E_0 is the reference illuminance at the water surface. Results are compared to other theoretical and experimental data, and show that the suggested approximations hold up fairly well for a limited optical depth range (τ = 0--5). A more general applicability of the formulas would depend on the particular scattering index which is being used. [Golubitskiy, B. M., i. M. Levin, and M. V. Tantoshev. Illuminance of sea water from an infinitely wide beam. FAiO, no. 7, 1974, 798-801].

UV Absorption in Seawater (abstract)

An experiment in correlation between seawater luminescence and its absorption in the u-v band was carried out in the Baltic Sea in September 1971, as reported by the authors earlier (FAiO, no. 9, 1971). The present article briefly compares some of the data from this exercise, and shows a correlation of 0.82--0.92 in the range of 250 to 390 nm. Below about 220 nm the correlation disappears. Similar data of distilled water are included for comparison. Results are analogous to those obtained in the South Atlantic (Armstrong, 1961), and indicate that natural waters generally contain organic matter of the melanoidine type whose absorption and luminescent properties are invariant. [Karabashev, G. S., and K. P. Zangalis. Absorption of u-v radiation and the luminescence of dissolved matter in seawater. FAiO, no. 7, 1974, 801-802].

Equipment for Underwater Bioluminescence Study (verbatim)

With the aim of increasing effectiveness in studies of bioluminescent fields, a new set of equipment has been developed which will register space-time variations of these fields as the ocean. The complex includes sensing devices and optical signal recording and processing elements. Data from a bioluminograph (sensitive photometer) is modulated to a pulse form and fed to a pulse amplitude analyzer; from here it is displayed on a control screen and goes also to a digital printout, recording potentiometer or to a computer for statistical analysis. [Equipment complex for studying a bioluminescent optical field. IN: Sb. astomatiz. nauch. issled. moroy i okeanov. Kiyev, 1973, 71-75 (RZhGeofiz, 5/74, no. 5V34)].

Machine Processing of Oceanographic Data (verbatim)

Contents of a monograph on oceanographic data processing are listed as follows:

Chapter 1 - Technology of collecting, processing and distributing continuous deep-water data. General description of technology for transcribing information from data logs to punch tape via teletype; a description of coding and error correction techniques; handling of tapes, including indexing, storage and forwarding to the shore base.

Chapter 2 - Mathematical treatment of the technology of collecting, processing and disseminating deep-water data. Includes a flow diagram for transmitting punch tapes to the shore terminal, a description of the instruction program for the shore-based operator for handling deep-water data.

Chapter 3 - Technology of recording historical deep-water data in both working and permanent storage; includes a description of the method for preparing a data base for recording information on punch tape.

Chapter 4 - Collection, machine processing, and dissemination of BT data.

[Filippov, D. M., L. I. Kolyaskina, and S. A. Oleynikov. Technology of machine processing of oceanographic information. Tr. VNII gidrometeorol. inform. Mirovoy tsentr dannykh, no. 2, 1973, 86 p. (RZhGeofiz, 8/74, no. 8V21)].

Optical Characteristics of the Tropical Atlantic (abstract)

A review is given on findings of optical parameters measured in the active layer of the tropical Atlantic. Data was recorded during the twelfth voyage of the R/V Akademik Kurchatov in the spring of 1972. Variation in intensity of light scattering and photoluminescence is analyzed as a function of current, temperature, salinity and oxygen content. Results show that character-

istics of both vertical and horizontal optical field structure are correlated with motion and transformation of organic suspensions. The increasing content with depth of such matter, causing variation in the absorptive index of light in the ocean, must be accounted for in a realistic optical model of the ocean. [Karabashev, G. S., A. N. Solov'yev, and V. V. Yakubovich. Effect of hydrological conditions on optical characteristics of the active ocean layer. Okeanologiya, no. 4, 1974, 623-629].

Effect of Heavy Current Electron Beam on Metal (abstract)

A discussion is given of the effects of a heavy-current electron beam, with energy of 0.8 Mev and peaks of 25 ka in 55 ns pulses, on stainless steel and copper targets. At current densities on the order of 1 ka/cm^2, microcavities were formed in the specimen with a size of 10^{-4} cm. In copper the cavities appeared as extended chains or filaments, with a spacing between filaments of about 10^{-2} cm. At higher current densities a shock wave formed in the specimen, and splitting of the rear face was observed. Possible mechanisms of the observed phenomena are suggested. [Dmitrenko, B. I., L. V. Leskov, G. P. Maksimov, S. L. Nedoseyev, V. V. Savichev, V. P. Smirnov, and A. M. Spektor. Studying the effects of a heavy current beam of relativistic electrons on metal. ZhTF, no. 9, 1974, 1969-1972].

Effects of Superstrong Magnetic Field on Matter (verbatim)

The effects are examined of a superstrong magnetic field on electron properties of cold dense matter, and on nuclei of atoms comprising the crystal lattice. The importance is emphasized of allowing for the anomalous magnetic moment of electrons, in any description of dense matter behavior in a superstrong field. [Shul'man, G. A. Properties of a cold dense substance in superstrong magnetic fields. Tomsk, 1974, 12 p. (RZhF, 9/74, no. 9Yell DEP)].

New Journals in 1975

The Nauka publishing house in Moscow has announced several new journals which will begin publication in 1975. They are:

-Journal of Technical Physics - Letters (24/yr)
-Programming (6/yr)
-Plasma Physics (6/yr)
-Astronomy Journal - Letters (monthly)
-Coordination Chemistry (monthly)
-Physics and Chemistry of Glass (6/yr)
-Bioorganic Chemistry (monthly)
-Biology of the Sea (6/yr)
-Human Physiology (6/yr)

Any of the pertinent titles will be added to the Informatics data base.

Recent Acquisitions

Aleksandrov, A. Ya., and M. Kh. Akhmetzyanov. Polyarizatsionno-opticheskiye metody mekhaniki deformiriyemogo tela (Polarizational-optical methods for the mechanical deformation of solids). Moskva, Izd-vo nauka, Glavnaya redaktsiya fiziko-matematicheskoy literatury, 1973, 576 p.

Grigor'yev, B. A. Impul'snyy nagrev izlucheniyami: Chast' pervaya. Kharakteristiki impul'snogo oblucheniya i luchistogo nagreva (Impulse heating by radiation. Part one. Characteristics of pulsed radiation and radiant heating). Moskva, Izd-vo nauka, 1974, 318 p.

Grigor'yev, B. A. Impul'snyy nagrev izlucheniyami. Chast' vtoraya. Nestatsionarnyye temperaturnyye polya pri impul'snom luchistom nagreve. (Impulse heating by radiation. Part two. Nonstationary temperature fields during pulsed radiation heating). Moskva, Izd-vo nauka, 1974, 726 p.

Izrael', Yu. A. Mirnyye yadernyye vzryvy i okruzhayushchaya sreda (Peaceful nuclear explosions and the environment). Leningrad, Gidrometeoizdat, 1974, 135 p.

Gerver, M. L. Obratnaya zadacha dlya odnomernogo volnovogo uravneniya s neizvestnym istochnikom kolebaniy (Inverse problem for a one-dimensional wave equation with an unknown vibration source). Moskva, Izd-vo Nauka, 1974, 119 p.

Akademiya nauk SSSR. Institut fiziki Zemli. Mashinyy analiz tsifrovykh seysmicheskikh dannykh; sbornik statey (Computer analysis of digital seismic data; collection of articles). Moskva, Izd-vo Nauka, 1974, 335 p. (SERIES: Vychislitel'naya seysmologiya, no. 7, 1974).

Gramenitskiy, P. M. Dekompressionnyye rasstroystva (Decompression sicknesses). Moskva, Izd-vo Nauka, 1974, 348 p. (SERIES: Problemy kosmicheskoy biologii, v. 25, 1974).

_____. Neytral'nyye tokovyye sloi v plazme (Neutral current layers in plasma). Trudy fiz, inst. im. Lebedeva, v. 74. Moskva, Izd-vo Nauka, 1974.

Kuznetsov, Yu. V., V. N. Shchebetkovskiy. and A. G. Trusov. Osnovy ochistki vody ot radioaktivnykh zagryazneniy (Fundamentals of cleansing water of radioactive pollution). Moskva, Atomizdat, 1974, 359 p.

AN SSSR. Sibirskoye otdeleniye. Institut optiki atmosfery. Moshchnyye nanosekundnyye impul'snyye istochniki uskorennykh elektronov (Powerful nanosecond sources of accelerated electrons). G. A. Mesyats, ed. Novosibirsk, Izd-vo Nauka, Sibirskoye otdeleniye, 1974, 167 p.

Rayzer, Yu. A. Lazernaya iskra i rasprostraneniye razryadov (Laser sparks and the propagation of discharges). Moskva, Izd-vo Nauka, 1974, 307 p.

Zeyger, S. G., Yu. L. Klimontovich, P. S. Landa, Ye. G. Lariontsev, and E. Ye. Fradkin. Volnovyye i fluktuatsionnyye protsessy v lazerakh (Wave and fluctuation processes in lasers). Moskva, Izd-vo Nauka, 1974, 415 p.

SOURCE IDENTIFICATION

DAN SSSR	-	Akademiya nauk SSSR. Doklady
FAiO	-	Akademiya nauk SSSR. Izvestiya. Fizika atmosfery i okeana.
FiKhOM	-	Fizika i khimiya obrabotki materialov
IVUZ Fiz	-	Izvestiya vysshykh uchebnykh zavedeniy. Fizika
IVUZ Radiofiz	-	Izvestiya vysshikh uchebnykh zavedeniy. Radiofizika
KSpF	-	Kratkiye soobshcheniya po fizike
RZhF	-	Referativnyy zhurnal. Fizika
RZhGeofiz	-	Referativnyy zhurnal. Geofizika
RZhRadiot	-	Referativnyy zhurnal. Radiotekhnika
TVT	-	Teplofizika vysokikh temperatur
ZhPMTF	-	Zhurnal prikladnoy mekhaniki i tekhnicheskoy fiziki
ZhTF	-	Zhurnal tekhnicheskoy fiziki