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PULSED LASERS AND LASER APPLICATIONS

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ABSTRACTS

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In virtually all spin exchange (optical pumping) experiments, spin polarized alkali atoms are produced in their ground state by depopulation optical pumping.

This work introduces a novel pumping technique allowing for pumping specific hyperfine *excited* states of the alkali atoms by the photodissociation of a transient alkali-rare gas diatomic molecule [2]. It has been shown that this technique can be used to manipulate the upper laser level populations and, therefore, the atomic gain of the alkali atomic lasers.

1. *Happer W., Miron E., Schaefer S., Schreiber D., van Wijngaarden W.A., and Zeng X.* Polarization of the nuclear spins of noble-gas atoms by spin exchange with optically pumped alkali-metal atoms // Phys. Rev. 1984. A 29. P. 3092.
2. *Mironov E., Hewitt J.D., and Eden J.G.* Spin Polarization of Rb and Cs np $^2P_{3/2}$ (n = 5,6) Atoms by Circularly-Polarized Photoexcitation of a Transient Diatomic Molecule // Phys. Rev. Let. 2017. V. 118. No. 11.

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COMPACT UV NITROGEN LASER PUMPED BY A PULSED LONGITUDINAL INDUCTIVE DISCHARGE

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The creation of a compact emitter of an inductive nitrogen laser (λ = 337.1 nm) is reported. For this purpose, a scheme for the formation of a pulsed induction longitudinal discharge of a transformer type has been developed. The emitter was a closed discharge circuit, which consisted of a capillary – a thin tube, which is the main working zone for generating radiation and the so-called "bypass channel". Its diameter is greater than the diameter of the capillary; this was done in order to reduce the impedance of the discharge gap. The length of the active zone of this emitter was 25 cm, the diameter of the capillary was 0.3 cm. An inductor was located along both sides of the discharge tube. In the literature, inductors of this type are called antennas. The method of pumping the active medium of a nitrogen laser with a pulsed induction longitudinal discharge of a transformer type was used for the first time. The experiments used a high voltage excitation system based on the Blumlein scheme.

In the created inductive emitter, the generation energy was about 0.35 mJ. The duration of the generation pulses was 15 ± 5 ns (FWHM), depending on the Q of the resonator. When a semi-confocal resonator was installed, it was possible to obtain a profile of the generation beam close to the Gaussian one. The spectral characteristics of spontaneous and laser radiation are analyzed. Just as with the pumping of nitrogen by an inductive discharge of cylindrical geometry, infrared radiation corresponding to low lying 1^+ transitions was not observed.

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GAS LASERS PUMPED BY DIFFUSE DISCHARGE FORMED BY RUN-AWAY ELECTRONS

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Laser parameters in run-away electron preionized discharges (REP DD) are presented. Efficient lasing was obtained in different spectral ranges from IR to VUV.

Ultimate efficiency of nitrogen and HF(DF) lasers was realized in the N_2–SF_6 and $H_2(D_2)$–SF_6 gas mixtures. The maximal energy at 337 nm in N_2–SF_6 mixture was 4.1 mJ which corresponds to ultimate efficiency of N_2 laser of > 0.2%. Peak radiation energy on HF molecules attained ≈ 110 mJ corresponding to the ultimate internal lasing efficiency ≈ 10%.

Pulse duration and efficiency of exciplex lasers on XeF*, KrF*, ArF* molecules and VUV laser on molecular fluorine pumped by REP DD were shown to be comparable with those parameters obtained in conventional transverse discharge with preionization.

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ELECTRON DRIFT CHARACTERISTIC IN He–Cu

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In this paper we consider the drift of electrons in helium with copper vapor in order to study the effect of copper concentration (fraction) on the electron transfer coefficients. The computational experiment is based on the consideration of an ensemble of noninteracting electrons, the motion of which is determined by given fields and instantaneous collisions with atoms.

The collision model is based on the procedure for generating random numbers-a method such as Monte Carlo. The realization of electron-atom collisions by the Monte Carlo method allows one to take into account the energy balance of electrons on the basis of elementary processes, including in inelastic collisions.

Calculated and analyzed the characteristics of electron drift in argon with mercury vapor when the electric field strength $E/N = 1 - 100$ TD taking into account inelastic collisions.

It is shown that even minor additives of the mercury in argon, since a fraction of a percent, greatly affect the discharge, in particular, on the characteristics of inelastic processes. The influence of the percentage of atoms of mercury in argon on kinetic characteristics – the coefficients of diffusion and mobility, frequency of ionization, etc.

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ON THE MECHANISM LIMITING THE FREQUENCY AND ENERGY CHARACTERISTICS OF THE METAL VAPOR LASERS

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The analysis of electrophysical processes in the discharge circuit of pulsed metal vapor lasers is carried out. The greatest attention is paid to the initial period of the development of the discharge and the conditions for the formation of inversion. It is shown that the limitation of the frequency-energy characteristics of the generation is caused by the process of populating the metastable levels of metal atoms on the front of the excitation pulse and redistributing the rates of population of the laser levels in favor of metastable with increasing prepulse electron concentration. Which of the processes plays a decisive role in limiting the frequency energy characteristics of the generation depends on the electrophysical process in the discharge circuit of the laser, the development of which is influenced by the location of the electrodes in the discharge tube. The arrangement of the electrodes in the discharge tube also determines the conditions for the formation of inversion and the choice of the optimum pump parameters. Technical solutions for which the pumping efficiency of a copper vapor laser can be – 10% are discussed.

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METHODS FOR NUMERICAL OPTIMIZATION OF THE CHARACTERISTICS OF THE STRONTIUM AND CALCIUM VAPOUR RECOMBINATION LASERS

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Ion recombination strontium ($\lambda = 430.5$ and 416.2 nm SrII) and calcium ($\lambda = 373.7$ and 370.6 nm CaII) vapour lasers are efficient sources of short wavelength radiation. In the present work the mathematical models of the He–Sr and He–Ca lasers was developed which comprises the description of the electrical pump circuit, the plasma of a repetitively pulsed discharge, and the laser