moments, reported in [2-4] for polycrystalline potassium ferrocyanide, are apparently connected with precisely the presence of small amounts of impurities in the investigated samples.

The influence of impurities on the NMR nuclei with spin $I > 1/2$ and with quadrupole moment is well known [5,6] and is due to the fact that the impurity atoms, vacancies, and other lattice defects produce different electric-field gradients at the places where the resonating nuclei are localized, and also to the decrease in the relaxation time, owing to the large diffusion rate in a crystal with defects.

This is the first observation of the described strong influence of relatively small impurity contents on proton magnetic resonance spectra. This phenomenon is apparently caused by the well known increase of the diffusion mobility (in this case, of the H_2O molecules) in a crystal with defects.

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LASER WITH NEODYMIUM-ACTIVATED α-GAGARINITE

(Devoted to Man's First Flight in Space)

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Submitted 18 January 1967
JETP Pis'ma 5 No. 7, 220-223 (1 April 1967)

Gagarinite is a natural fluoride of rare earths (TR^{3+}), sodium, and calcium, with idealized formula $NaCaYF_6$. This mineral was discovered in the USSR in 1958 [1] and named in honor of the first astronaut in the world Yu. A. Gagarin.

In this communication we present preliminary results of investigations of a new laser based on an α-gagarinite crystal activated with Nd^{3+} and operating at 300°K.

We used α-gagarinite crystals grown by the Stockbarger method in an HF atmosphere [2]. As is well known, gagarinite has two polymorphic modifications, the high-temperature one having a fluorite-type structure. In a definite region of the $NaF-CaF_2-YF_3$ system, the cubic modification (α) is retained in a wide temperature interval. It is this α modification which we investigated.

The samples for the study of the stimulated emission were prepared from synthetic single crystals of satisfactory optical quality in the form of cylindrical rods ~30 mm long and ~6 mm in diameter, with plane-parallel (~15") end faces. The activating-impurity con-

centration ranged from 0.5 to 1% by weight.

There are by now several known lasers based on the fluorite-structure phases in double-fluride systems MF_2-MeF_3-TR^{3+}, where M - Ca, Sr, or Ba and Me - Y, La, Ce, or Er [3,4]. A distinguishing feature of the crystal-chemical structure of these phases is the disordered arrangement of the ions of the different components, which in final analysis is reflected in the configurations of the crystalline electric fields surrounding the TR^{3+} working ions. This circumstance leads to the formation of a large number of types of optical centers (OC). As noted in [5], these phases are typically crystalline in their structure, but occupy a position intermediate between crystals and glasses with respect to their spectral properties.

The α-gagarinite crystals obtained by us paved the way to a new series of active laser media, namely crystals of ternary fluoride systems. These crystals are also included in the class of substances considered above, i.e., they are characterized by a great variety of OC.

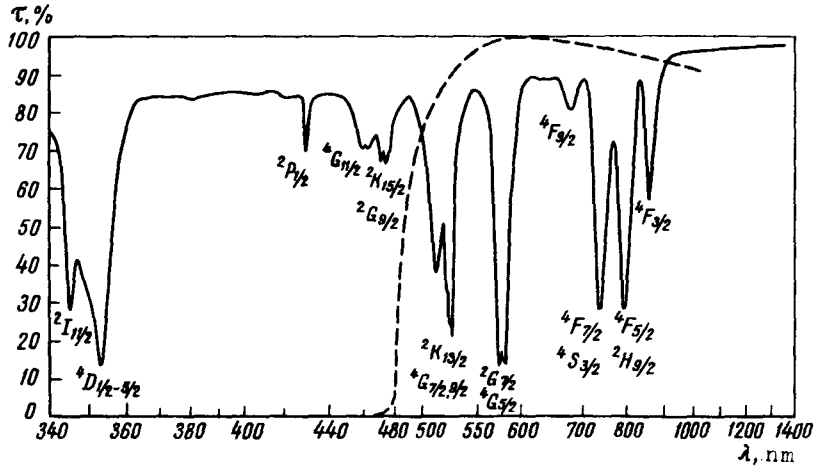

Fig. 1. Transmission spectrum of α-gagarinite crystal with 1% Nd^{3+} at 300°K.

Figure 1 shows the transmission spectrum of an α-gagarinite crystal with Nd^{3+} (1%), obtained with an EPS-2U spectrophotometer at 300°K in the range from 3400 to 14 000 Å. The infrared luminescence of the Nd^{3+} corresponds to transitions from the levels of the term $^4F_{3/2}$ to four components of the main multiplet ^4I. As in the majority of other media, the strongest luminescence of Nd^{3+} corresponds to the transition $^4F_{3/2} \rightarrow {}^4I_{11/2}$.

In the lasing experiments we used a cylindrical illuminating system of elliptic cross section with optical efficiency ~0.3 [6]. The major semiaxis of the illuminator was 31 mm, the length was 55 mm, and the eccentricity was ~0.43. The excitation source was a xenon flash lamp of IFP type (interelectrode gap ~45 mm, diameter of luminous column ~5 mm). The optical cavity consisted of spherical mirrors with dielectric coating ($r \approx 0.5\%$), which were mounted confocally. To prevent the harmful effect of neodymium "aging" [7,8], the working crystal was placed in a tube of ZhS-17 glass, whose transmission spectrum is shown by the dashed line in Fig. 1. We see that in our experiment the crystals were excited in Nd^{3+} absorption bands between 9000 and 20000 cm^{-1}.

The spectral structure of the laser emission was investigated with a DFS-8 spectrometer (6 Å/mm). The spectrum was photographed on I-1070 film. The reference was the third-order spectrum of iron. A tube with hollow cathode was used. Figure 2 shows the stimulated-emission spectra of two α-gagarinite crystals at different activator concentrations and excitation energies. Figure 2a shows the lasing spectrum of a crystal with 0.5 wt.% Nd^{3+}, obtained at threshold excitation energies. We see that emission takes place at a single line with wavelength 10 538 Å (9489 cm^{-1}). The excitation threshold of this line was in our system ~11 J.* When the excitation was increased to 27 J, a second line with λ = 10 629 Å (9408 cm^{-1}) appeared in the spectrum (Fig. 2b). The behavior of these lines in a crystal with 1 wt.% Nd^{3+} is already somewhat different; first, the lines shift somewhat towards longer wavelengths λ = 10 540 Å (9488 cm^{-1}) and λ = 10 631 Å (9406 cm^{-1}) (Fig. 2c) and second, the excitation threshold of the second line drops to E_2 = 20 J (E_1 = 14 J). It should be noted that the optical quality of the second crystal was somewhat worse than the first.

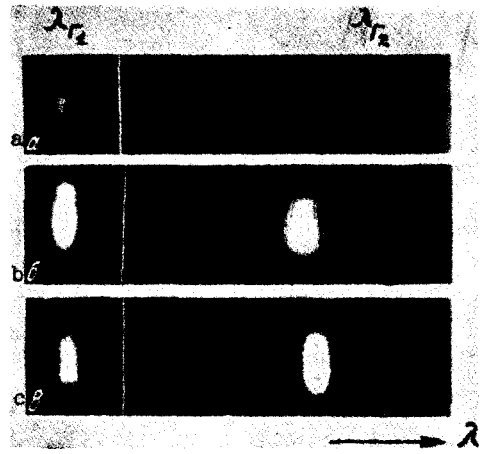

Fig. 2. Lasing spectra of α-gagarinite crystal at 300°K: a - with 0.5% Nd^{3+}, E_{exc} = 12 J; b - with 0.5% Nd^{3+}, Eexc = 50 J; c - with 1% Nd^{3+}, E_{exc} = 50 J.

Such a strong dependence of the spectra of α-gagarinite on the concentration of the activator (or of other components) favors the assumption that considerable rearrangements of the OC (or the appearance of new ones) and changes in the lasing properties, are possible in this system. This feature may make lasers with controlled spectral characteristics feasible.

In conclusion, we thank D. N. Klushantsev and G. A. Bogomolova for taking part in the experiments, N. Ya. Vinogradov for processing the crystals, and Z. B. Perikalina for plotting the transmission spectrum.

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* The indicated values of the threshold excitation energies make due allowance for the length of the crystal and the interelectrode gap of the pump lamp.

MULTIPHOTON IONIZATION OF XENON AND KRYPTON ATOMS AT WAVELENGTH $\lambda = 1.06\ \mu$

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Submitted 18 January 1967
JETP Pis'ma 5, No. 7, 223-225 (1 April 1967)

We present here the first results on multiphoton ionization of xenon atoms (I = 12.13 eV) and krypton atoms (I = 13.996 eV) by neodymium-laser emission ($\lambda = 1.06\ \mu$, $\hbar\omega = 1.18$ eV) at a light-wave electric field intensity $E \cong 4 \times 10^7$ V/cm. The experimental setup was similar to that used earlier to investigate multiphoton ionization of the same atoms by ruby-laser emission ($\lambda = 0.69\ \mu$, $\hbar\omega = 1.78$ eV) [1].

At an emission intensity $F = 10^{31.4\pm0.3}$ photons/cm^2-sec ($E \cong 4 \times 10^7$ V/cm), the ionization probability is proportional to the emission intensity raised to the power $K = 8.8 \pm 0.2$ for xenon and $K = 9.1 \pm 0.1$ for krypton.

If the radiation field does not exert a significant effect on the states of the atomic system, then the exponent in the dependence of the ionization probability on the emission intensity should be equal to the number of quanta abosrbed upon ionization, which, in accord with the energy conservation law, is equal to $K_0 = \langle I/\hbar\omega + 1\rangle$, where the symbol $\langle x\rangle$ denotes the integer part of the quantity x. The experimental values of K are much lower than the corresponding values of K_0, which are 11 for xenon and 12 for krypton. Values of K lower than K_0 were obtained earlier at the same electric-field intensity at the ruby-laser wavelength $\lambda = 0.69\ \mu$ [1]. From our point of view, these results are evidence that an appreciable contribution is made to the ionization probability by transitions between bound states, and that the radiation field has a strong influence on these states [1].

A qualitative explanation why the observed value of K is smaller than K_0 is afforded by two effects - lowering of the effective ionization potential by the overlap and merging of the upper energy levels in the atom [2], and change in the width and detuning of the resonance of the intermediate quasiresonant levels [3]. It is interesting to note that although the quantum energy in our experiments differs greatly, the quantity $I - K\hbar\omega$ is independent within the limits of experimental error, of the radiation wavelength and is much larger for krypton than for xenon. In the case of transitions between quasiresonant levels, the quantity $I - K\hbar\omega$ depends on the relative placement of the atomic energy levels and on the energy of an entire number of emission quanta, reckoned from the ground state, and should therefore be a random quantity for different atoms and emission-quantum energies. From this point of view, the difference in the values of $I - K\hbar\omega$ for Xe and Kr is natural, and the independence of the quantum energy can be due only to the randomness. The amount by which