field corresponds to a minimum of the oscillations

$$\cos\left(\frac{2\pi\xi}{\hbar\Omega} - \frac{\pi}{4}\right) = 1 ,$$

then σ_{xx} increases with increasing electric field. Consequently, the change of the conductivity is due to the change of the oscillating part, since x becomes of the order of unity at relatively small T_e. (In our experiments $T_e \leq 40°$, i.e., $kT_e/\xi << 1$). An experimental reduction has shown that the monotonic part of σ_{xx} remains practically independent of E up to electric fields 0.3 - 0.55 V/cm (for different curves).

Figure 2 shows the current-voltage characteristics corresponding to points 1, 2, and 3 on the oscillation curve (see Fig. 1) at different values of the magnetic field intensity. It is seen from the figure that the electric field at which the deviation from Ohm's law begins (E_{cr}) increases with increasing magnetic field intensity. It follows from (1) and (2) that apparently $E_{cr} \sim H^{3/2}$, which agrees qualitatively with experiment. Analogous results were obtained also for n-InSb.

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ELECTRON NUCLEAR DOUBLE MAGNETOACOUSTIC RESONANCE AND Cr^{3+} - Al^{27} INTERACTION IN RUBY

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Acoustic NMR was detected for the first time with the aid of the electron spin system. Lines of the acoustic NMR of Al^{27} in a laser ruby single crystal were observed in the form of dips as a function of the frequency of the ultrasound against the background of the EPR line of the Cr^{3+} ions. This new principle of detection of acoustic NMR increases the sensitivity of the acoustic measurements, makes it possible to investigate electron-nuclear interactions in crystals, and to clarify the dynamics of the occurrence of double resonances in multicomponent quantum systems.

As is well known [1], the electronic cross relaxation plays an important role in the redistribution of the energy absorbed by the Cr^{3+} spins in the EPR process in Al_2O_3, and also in the establishment of the stationary population difference of the electronic spin system and of the intensity of the EPR signal. However, in view of the small specific heat of the Cr^{3+} - Cr^{3+} dipole-dipole system proceeds via a close coupling of this system with the Zeeman reservoir of the Al^{27} spins. This gave rise to the idea of using this circumstance for the detection of acoustic NMR on Al^{27}: by saturating the acoustic NMR on the Al^{27} nuclei, we block the channel through which energy flows out of the Cr^{3+} - Cr^{3+} dipole-dipole system, and

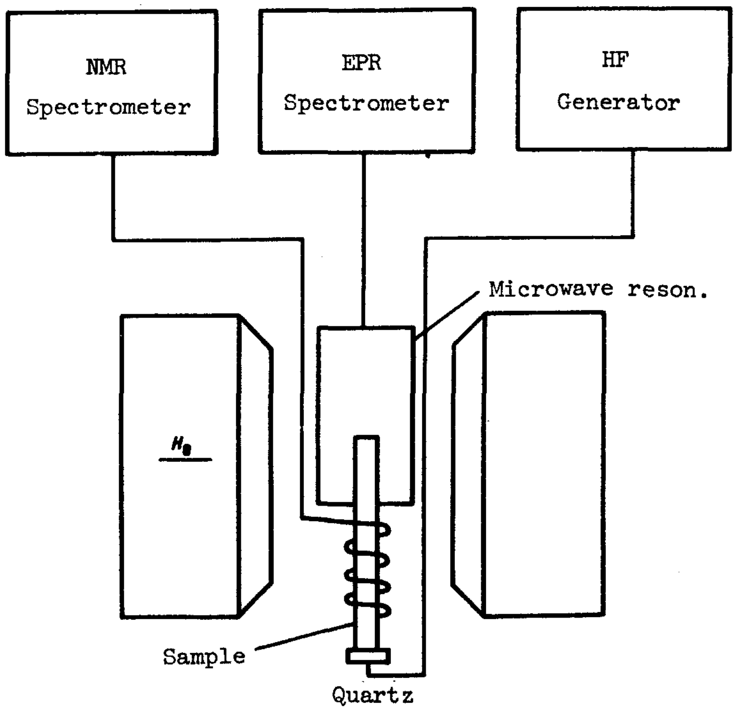

Fig. 1. Block diagram of acoustic electron-nuclear double-resonance spectrometer.

this slows down the longitudinal relaxation of the Cr^{3+} ions and decreases the intensity of the EPR signal. The experiment described below has confirmed the suitability of our new scheme of observing acoustic NMR.

The electron-nuclear double magnetoacoustic resonance investigations were performed with a laser ruby single crystal containing 0.05 at.% Cr^{3+}. The sample was a hexagonal rod 47 mm long and 5 mm thick, with the trigonal axis (C) parallel to the end faces (Fig. 1). One end of the sample was placed in the reflecting-type rectangular resonator of the EPR spectrometer. Quartz converters operating in appropriate frequency bands were connected to the other silver-coated end of the sample. To excite acoutic waves in the system, the quartz converter was connected through a matching device, to a continuously-tunable high-frequency generator. The quartz converter was enclosed in a screen to protect the sample against the electromagnetic waves exciting the quartz. In all the experiments, we verified that such electromagnetic oscillations had no influence on EPR signal, by replacing the quartz with a piezodielectric of identical dimensions. The alternating deformation arising upon propagation of the sound wave was first measured with a capacitive pickup, and was monitored during the double-resonance measurement by an impedance method.

Since we used a sample with plane-parallel end faces, longitudinal mechanical resonances, characterized by a sharp increase of the oscillation intensity, were produced in it at definite intervals ($\sim$ 100 kHz). For frequency sweeping we used the sections between the mechanical resonances, where the deformation amplitude changed little.

The procedure for measuring the electron-nuclear double magnetoacoustic resonance consisted of the following: A magnetic field H_0 = 2700 G, parallel to the C axis of the ruby, was produced and corresponded to the maximum of the first derivative of the EPR line of the Cr^{3+}

for the transition (1/2 ↔ -1/2). Simultaneously, longitudinal acoustic waves perpendicular to both H_0 and the C axis of the ruby were excited along the sample. Further, at constant H_0, we registered the variations of the first derivative of the absorption signal while sweeping of the frequency of the acoustic oscillations. This revealed an average decrease of 15% in the EPR signal for a relative deformation $\sim 2 \times 10^{-7}$ at the acoustic-oscillation frequencies corresponding to the transitions of the nuclear spin of Al^{27} between levels with $\Delta m = \pm 1$ and $\Delta m = \pm 2$ for the given H_0 and crystal orientation (Fig. 2). These resonance lines had a Gaussian form when calculated with allowance for the deformation amplitudes within the limits of the resonant peak.

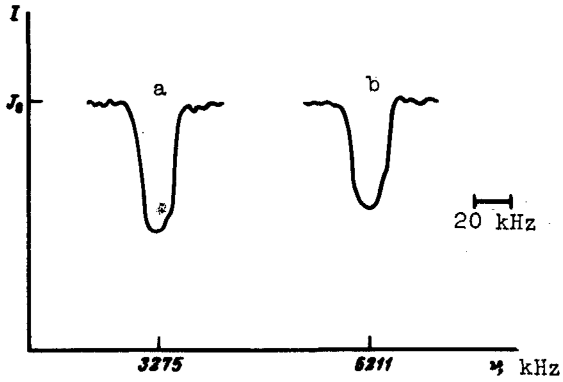

Fig. 2. ANMR signals of Al^{27}: a - $|1/2 \leftrightarrow 3/2\rangle$ transition, b - $|1/2 \leftrightarrow 5/2\rangle$ transition.

The coefficient $\tau_a \sim 10^{-9}$ cm^{-1} for ultrasound absorption by the Al^{27} spin system in Al_2O_3 is very small, since the Al^{27} energy levels are not equidistant and the acoustic NMR line has a large width ($\Delta\nu_a \sim 2 \times 10^4$ sec^{-1}). Therefore, there are as yet no direct measurement data on τ_a of corundum (method A). Method B of the saturating ordinary NMR with sound [3] turned out to be more promising, but in that investigation they used intense sound, which made it impossible to investigate in detail the line shape of the acoustic NMR. Method C of electron-nuclear double magnetoacoustic resonance is more sensitive than method B by a factor

$$\eta = (1/3)/(1/8) \left[\frac{I(I+1)(h\nu_n)^2 N}{(h\nu_e)^2 n}\right]$$

where I is the nuclear spin, ν_n and ν_e are respectively the EPR and NMR frequencies, $\Delta\nu_e$ is the EPR width, and N/n is the concentration of the paramagnetic ions in the crystal. This relation is a reflection of the fact that the thermal reservoir of the Al^{27} spins is replaced by the dipole-dipole reservoir of the Cr^{3+}-Cr^{3+} interactions, and the NMR frequency is replaced by the EPR frequency, with account taken of the fact that the EPR line width exceeds the NMR line width.

When $\Delta\nu_e = 6 \times 10^7$ sec^{-1}, we obtain $\eta \sim 10^3$, which is in reasonable agreement with the results of [3]. Thus, our investigation confirms the existence of a close coupling between Cr^{3+}-Cr^{3+} and Al^{27} systems, which may explain the nature of the spin-lattice relaxation of Al^{27} nuclei in ruby. The prospects of the double resonance method in quantum acoustics are favored also by recently observed effects of this type, namely investigations of acoustic NMR with the aid of ordinary NMR [4], polarization of Si^{29} nuclei by hypersound [5], and modulation of the acoustic EPR signal of the U^{4+} ion in CaF_2 with the aid of NMR [6].

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GENERATION OF COHERENT RADIATION AT λ = 2120 Å BY CASCADE FREQUENCY CONVERSION

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1. The purpose of the present paper is to report the results of an experimental investigation that has led to the development of a source of intense coherent radiation at a wavelength λ = 2120 Å. Ultraviolet (UV) radiation of ~ 1 kW power was obtained by synchronous cascade generation of the fifth harmonic of the radiation of a neodymium laser in a KDP crystal. The strong frequency dispersion of the synchronism direction in the UV region causes the generation of the fifth harmonic to be accompanied by an appreciable narrowing of the spectrum $\Delta\lambda_5$. In our experiments $\Delta\lambda_5$ did not exceed $\Delta\lambda_5^{lim}$ = 1 Å, regardless of the width of the spectrum of the fundamental radiation (of course, provided $\Delta\lambda_1 > \Delta\lambda_5^{lim}$).

2. Up to now, the shortest wavelengths obtained by nonlinear-optics methods under contions of accumulating interactions with KDP and ADP crystals are λ = 2650 Å, the fourth harmonic of a neodymium laser (see [1 - 3]) and λ = 2573 Å, the second harmonic of an argon gas laser (see [4, 5]). These wavelengths are not the shortest possible, the edge of the absorption edge for the KDP and ADP crystals lies near λ = 2000 Å [10]. When it comes to powerful solid-state lasers, the most convenient scheme for advancing further in the UV region is admittedly the generation of the fifth harmonic of the emission of a neodymium laser; the total absorption of the KDP crystal used by us at λ_5 = 2120 Å was 60%. This is precisely

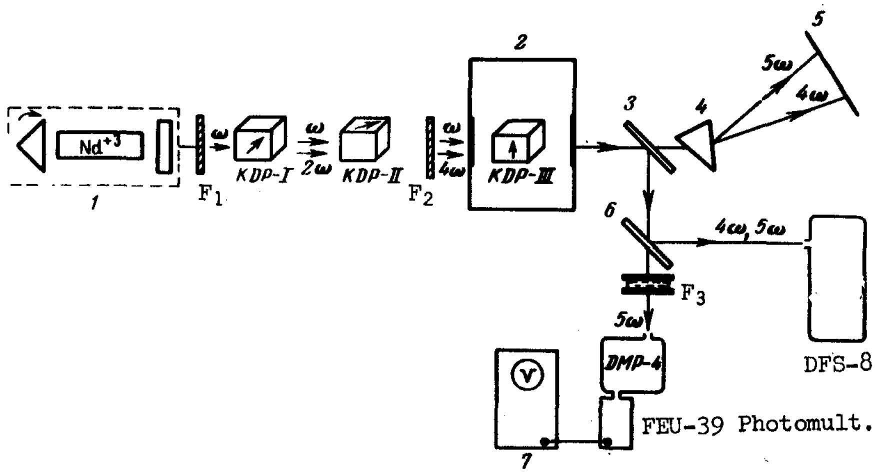

Fig. 1. Block diagram of experimental setup for the generation of the fifth harmonic of a neodymium laser.