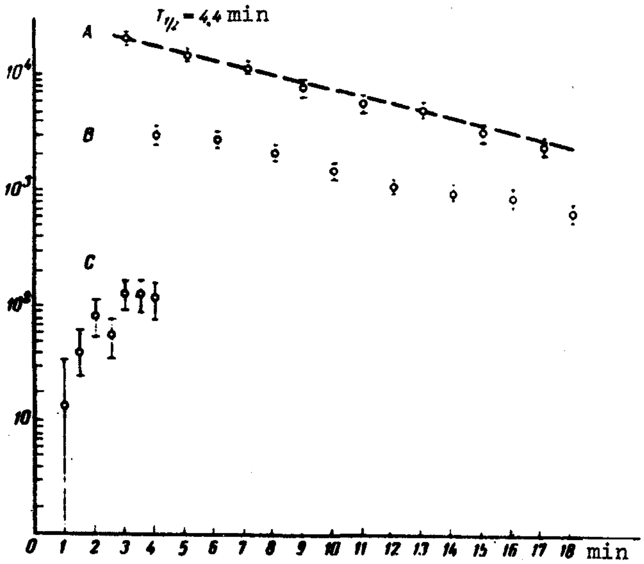


Change of intensity of the 148-keV line of $^{92}Tc$ with time: A - in the technetium fraction, B and C - in the ruthenium fraction. The time marked on the abscissa axis is reckoned from the instant of termination of the chemical separation of the corresponding fractions.

In the γ spectrum of the ruthenium fraction we observed the lines 134, 202, and 260 keV, which decayed approximately with the same half-life ∿2.5 min. It can be assumed that at least some of them result from the decay $^{92}Ru \rightarrow {}^{92}Tc$. The experiments on the identification of these lines and also on the refinement of the half-life of $^{92}Ru$ are being continued.

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## POLARIZATION ECHO IN THE FERROELECTRIC SINGLE CRYSTAL $KH_2PO_4$

U.Kh. Kopvillem, B.P. Smolyakov, and R.Z. Sharipov
Kazan' Physico-technical Institute, USSR Academy of Sciences
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An electric analog of electronic spin echo was observed at helium temperatures in single-crystal $KH_2PO_4$ at a frequency $10^{10}$ $sec^{-1}$. The echo responses have a high intensity, a duration on the order of $3 \times 10^{-8}$ sec, and are independent of the magnetic field intensity. An analysis of the experimental data shows that the polarization echo is due to a system of localized centers having an electric dipole moment. The reversible phase relaxation of this system is due to the inhomogeneity of the local electric field in the ferroelectric. The times of longitudinal reversible transverse and irreversible transverse relaxations of these centers at helium temperatures are respectively on the order of $T_1 \sim 10^{-5}$ sec, $T_2^* \sim 10^{-8}$ sec, and $T_2 \sim 1.6 \times 10^{-6}$ sec. In [1 - 3] they reported experimental observation of cyclotron, ferromagnetic, and flexoid echo. In [4 - 6] these phenomena were described theoretically from a unified point of view as responses of a system of coherently excited quantum oscillators, and were called macroscopic echo signals. Since the excitation of the proton oscillations and vortex filaments in helium, of domains in paramagnets and ferroelectrics, tubes of self-trapped radiation in optically excited media, and of defects in crystals can be described by the same formalism, the problem

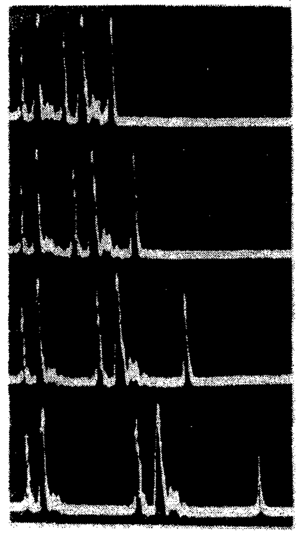

Figure. Oscillograms of polarization echo signals in $KH_2PO_4$ at 4.2°K for different intervals between the exciting pulses ($\tau$ ranged from $10^{-7}$ to $3 \times 10^{-7}$ sec). After each exciting pulse (narrow peaks) there was observed a sequence of successive reflection of hypersound pulses from the domain walls. The second hypersonic signal is followed by polarization echo.

arises of searching for corresponding signals. We report here observation of macroscopic echo in ferroelectric potassium hydrophosphate.

The experiments were performed by the pulsed method used to observe electronic spin echo [7]. The source of powerful microwave pulses was a magnetron oscillator. The pulse power of the generator was on the order of 4 kW. To register the echo signals we used a direct amplification receiver using traveling-wave tubes with a bandwidth on the order of 40 MHz and a sensitivity $10^{-12}$ W.

A series of two exciting microwave pulses of duration on the order of $3 \times 10^{-8}$ sec and with an interval $\tau$ between pulses was fed to the input of a three-arm ferrite circulator and further into a reflecting cavity resonator with a loaded Q on the order of 500.

A KDP ($KH_2PO_4$) crystal, cut in the form of a cylinder of 4 mm diameter and 6 mm length, was placed at the maximum of the electric field of the microwave resonator. The crystal was neither ground nor optically treated. A polarization echo was observed after an interval following the leading front of the first exciting pulse. With increasing interval between the exciting pulses, the amplitude of the echo decreased with a time constant $T_2$. The figure shows oscillograms of the echo signals at different intervals $\tau$ between the exciting pulses.

By virtue of the photoelectric properties of the $KH_2PO_4$ crystals, after each exciting pulse there was observed generation of hypersound, analogous to that described in [8]. When a series of three microwave pulses was applied to the crystal, we observed, in addition to the echo signal following the second pulse, also signals of the so-called stimulated echo, at intervals $\tau$ and $2\tau$ following the third exciting pulse. At a fixed delay between the first and second exciting pulses, the amplitude of the stimulated echo decreased with increasing interval between the second and third pulses, at a time constant $T_1$.

The observed echo signal cannot be an apparatus effect, for when $\tau$ is increased the echo signal always is observed at an interval $2\tau$ following the first pulse, as expected from the theory of the macroscopic echo. We conclude therefore that the signal is due to coherent oscillation of electric dipoles localized in space.

Analogous experiments were carried out with polydomain $LiNbO_3$, Rochelle salt, and crystalline quartz. In all cases we observed hypersound, but echo signals were never observed. This indicates, first of all, that the polarization echo observed by us is not a hypersonic signal.

In addition, it is seen from the presented oscillograms that hypersonic pulses are excited in the crystal after both the first and the second exciting pulses. As to the echo signal, it is not accompanied by any hypersonic oscillations.

We can draw the following conclusions from these experiments: 1) It follows apparently from the absence of the polarization-echo signal in quartz that the polarization echo is connected not with the piezo-effect, but with the ferroelectric state of the material. 2) The absence of a signal in lithium niobate can be attributed to the fact that this substance has a very high phase-transition temperature. At the temperatures of the experiment, the domain boundaries and the domains themselves have low mobility. It is therefore possible that the polarization echo signal is due to some degree to the mobility of the domain boundaries, or to the rotation of the domains themselves. 3) The absence of a signal in Rochelle salt may be due to the fact that the crystal goes over into the paraelectric state at helium temperatures.

The following can be stated concerning the nature of the echo signals: 1) The phenomenon is due to polarization (phasing) of the electric dipoles of the material. 2) When the excitation frequency changes from 8.9 to 9.6 GHz, the intensity of the echo does not change, i.e., the excitation does not have a resonant character. 3) With increasing excitation intensity, the echo signal increases monotonically and reveals symptoms of saturation at a power $\sim$1 kW. The symptoms in items (2) and (3) are characteristics of the macroscopic echo [4 - 6]. The short relaxation time at helium temperatures and the signal intensity, which exceeds the signals of electronic spin echo on paramagnetic impurities, indicate that we are dealing with electric dipoles. Polarization echo was observed also at 4.2°K in the ferroelectric single crystals $KD_2PO_4$, $CsD_2AsO_4$, $CsH_2AsO_4$, $RbH_2AsO_4$, and $RH_2PO_4$. We see therefore that the polarization echo is a characteristic phenomenon for ferroelectrics. One can hope that it can become a new method for investigating these substances.


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## TEMPERATURE DEPENDENCE OF THE INTENSITY OF NMR OF HEXAGONAL COBALT


A.N. Pogorelyi and V.V. Kotov
Institute of Metal Physics, Ukrainian Academy of Sciences


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The hyperfine interaction in ferromagnets leads to occurrence at the nuclei of an effective alternating field (H) connected with the applied field (h) by the relation [1]:

$$H = \eta h, \tag{1}$$

where $\eta$ is the gain of the radio-frequency field at the nucleus, and is determined by the character of the magnetization of the ferromagnet. In the general case, one should speak of two gains, one pertaining to nuclei located in the domain boundaries and expressed in terms of the displacement susceptibility