beams of fast particles[1-4]. In all similar experiments the direction of particles undergoing second scattering was done by means of scintillation counters. In the present work it was attempted to determine the polarization of beams of protons and neutrons by photographic means from the observation of quasi-elastic scattering of protons from the nucleons of the nuclei of elements that make up the emulsion. The proton beam was obtained by scattering, at an angle of 18°, the internal beam of energy 670 mev in the synchrocyclotron. The scatterer-polarizer was Be target of thickness 4 cm. The medium energy of protons in the partly polarized beam was 570 mev[5]. In this beam were placed photographic plates with emulsions 200μ thick, capable of recording relativistic particles. In one of the experiments the plane of the emulsion was the same as the plane of the first scattering, in other experiments the plane of emulsion was perpendicular to the plane of the first scattering. The placing of the plates was thus selected to correspond to the planes of azimuthal angles 0 - 180° and 90° - 270°.

The stars generated by the protons in the emulsion contained gray tracks whose projections were in the interval of scattering angles $0° \leq \theta \leq 50°$ to the right and to the left depending on the direction of motion of the initial proton beam. Only those tracks were counted whose length exceeded 400 μ and whose density of grains corresponded to proton energies above 200 mev. In plates placed in the 0°- 180° plane, there were recorded 735 such tracks to the right while 922 tracks were recorded to the left. The corresponding value of the asymmetry is $\epsilon(\theta) = 0.11 \pm 0.03$. In plates placed in the 90°- 270° plane similarly 203 and 215 tracks were found to the right and left respectively. These values give $\epsilon(\theta) = 0.03 \pm 0.05$ which shows the presence of asymmetry in the 90°- 270° plane, as should be expected.

Under the same conditions of selection of tracks, measurements of asymmetry were made from gray tracks in stars produced by neutrons. A beam of neutrons with a broad energy spectrum was produced by charge exchange of protons in a Be target. Neutrons that were scattered from the target at angle 20° to the direction of motion of the proton beam in synchrocyclotron were incident on a photographic plate placed in the plane of the first scattering. In this case the following tracks were registered: to the right 667, to the left 747, yielding the asymmetry 0.06 ± 0.03.

The asymmetry of emerging fast particles after quasi-elastic collisions, found in the described experiments, shows that beams of protons and neutrons originating from interactions of protons of energy 670 mev with Be nuclei are partially polarized.

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The Excitation of Ultrasonic Vibrations by Ponderomotive Forces

S. I. Aksenov, B. P. Vikin and K. V. Vladimirskii
P. N. Lebedev Institute of Physics, Academy of Sciences, USSR
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During the work with apparatus intended for investigation of nuclear magnetic resonance[1], an interfering resonance effect was observed at frequencies of the order of several megacycles. It was found that this effect was produced by excitation of ultrasonic vibrations by ponderomotive forces in the copper conductor of which the spectrometer coil was constructed. With each of the coils used a series of resonance peaks was observed during a change of the working frequency. The amplitudes of the peaks exceeded considerably the noise level of the instrument. The relative width of the peaks was of the order of magnitude 1:100. The amplitude of the peaks increased linearly with the increase in depth of modulation of the field. The instantaneous values of the other losses present in the circuit depend on the field quadratically. In field of 10^4 oersteds with doubled amplitude of the modulation field (15 oersteds) the strongest resonant lines correspond to modulation of autodyne radiofrequency spectrometer of $\Delta U/U \sim 10^{-6}$. Since the spectrometer was used in a region far from the threshold of self-excitation, this is the change in the Q of the coil as well. The full change in the Q of the coil on application of the field of 10^4 oersteds is $\Delta Q/Q \sim 10^{-3}$. This ratio gives the fraction of energy which was dissipated in generation of the ultrasonic waves.

The connection of the phenomenon with the excitation of ultrasonic vibrations was indicated by the strong decrease of the resonance peaks after application of a thick layer of lacquer. Experiments with coils of different geometry showed that the resonant frequencies depend only on the diameter of the conductor. During a change of the diameter of the conductor, the product of the resonant frequency and the diameter of the conductor remains constant. As a result, it is natural to postulate that resonant frequencies correspond to the natural frequencies of vibration in the mass of the cylindrical conductor. The displacements would lie in the plane of the cross section of the conductor and would not be dependent on the coordinate in the direction of the axis of the conductor (this postulate agrees with the nature of the forces that excite the vibrations). One of the three equations for the free vibrations of a circular cylinder then turns out to be an identity. The solution of the problem was obtained from the solution of vibrations of a circular plate in its cross section [2]. The following values were used for the velocity of propagation of the longitudinal and lateral vibrations in copper: $v_l = 4700$ m/sec, $v_t = 2260$ m/sec[3].

The numerical solution of the equations yielded the following eigenvalues of the product of the wave number ω/v_l and the radius of the conductor:

	$\alpha_{21} = 1.12.$	$\alpha_{11} = 1.38;$
$\alpha_{31} = 1.77;$	$\alpha_{22} = 2.13;$	$\alpha_{01} = 2.18;$
$\alpha_{41} = 2.22;$	$\alpha_{02} = 2.46;$	$\alpha_{32} = 2.96;$
$\alpha_{12} = 3.18;$	$\alpha_{13} = 3.72;$	$\alpha_{42} = 3.74;$
$\alpha_{23} = 3.85;$	$\alpha_{03} = 4.05;$	$\alpha_{33} = 4.48;$
$\alpha_{14} = 4.78;$	$\alpha_{24} = 4.98;$	$\alpha_{04} = 5.43.$

The first subscript determines the angular dependence of the eigenfunction of the type cos $n\vartheta$. the second subscript (the order of the root) determines the nature of the radial dependence. The eigenvalues α_{01}, and α_{04} correspond to the radial vibrations, the eigenvalues α_{02} and α_{03} to tangential vibrations. The deviation of the calculated constants from the results of the measurements do not exceed 2%:

Experiment I (diameter of conductor 0.51 mm): $\alpha_{21} = 1.12$; $\alpha_{11} = 1.38$; $\alpha_{01} = 2.17$;

Experiment II (diameter of conductor 1mm): $\alpha_{01} = 2.18$; $\alpha_{02} = 2.48$; $\alpha_{32} = 2.98$; $\alpha_{12} = 3.20$; $\alpha_{13} = 3.76$; $\alpha_{03} = 4.08$;

Experiment III (diameter of conductor 1.5 mm): $\alpha_{12} = 3.19$; $\alpha_{12} = 3.75$; $\alpha_{23} = 3.88$; $\alpha_{03} = 4.08$; $\alpha_{14} = 4.82$; $\alpha_{24} = 5.05$; $\alpha_{04} = 5.49$.

The lower modes of vibration were dominantly excited. The most strongly excited vibrations were those corresponding to the eigenvalues α_{11}, α_{12}, since the angular dependence of the displacement is the same as that of the ponderomotive forces. The resonance, corresponding to the eigenvalue α_{32}, was observed in the form of a weak line, the resonance corresponding to α_{31} was observed only in the work with aluminum conductors.

The excitation of vibrations whose angular dependence was different from the angular dependence of the ponderomotive forces and the considerably greater width of the resonance lines observed during the experiments, can be explained by the presence of a firm mechanical contact between the turns of the coil and the frame. The damping of ultrasonic vibrations in metals, known from other measurements [3], should bring the relative width to the order of magnitude 10^{-3}. It is interesting to note that at the frequency of 12.5 mc, a narrow resonance line was observed with largest amplitude with a coil made of lead conductor of diameter 1 mm. This points to small damping in lead at those frequencies. Splitting of some resonance lines was observed during the experiments but was not followed up in detail.

Using the experimental values of the widths of the resonance lines, an estimate of the magnitude of the effect may be made. The ponderomotive forces can be considered as applied to the surface of the metal, since the skin depth is in the present experimental conditions considerably smaller than the diameter of the conductor and the wavelength of the ultrasonic waves. The power of the ultrasonic waves, emitted from a unit surface area of the metal into the mass of the conductor is inside the resonance (in the absence of standing waves), within an order of magnitude equal to:

$$P_u \sim f^2 v_t / 2\mu,$$

where f is the surface density of the ponderomotive forces, μ is the shear modulus. The relationship of this power to the total power around the circumference is

$$P_u / P_{tot} \sim H^2 v_t \delta\lambda / 2\mu,$$

where δ is the skin-depth and λ is the conductivity. For $H = 10^4$ oersteds and frequency 3×10^6 cps and $\delta \sim 4 \times 10^{-3}$ cm, $P_s/P_{tot} \sim 5 \times 10^{-5}$. Multiplying this number by the factor obtained from the experimental line widths a number is obtained, close to the experimental value $P_s/P_{tot} \sim 10^{-3}$. This result relates to the modes of vibration that are most strongly excited.

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The Fine Structure of the Spectrum of the Paramagnetic Resonance of the Ion Cr^{3+} in Chromium Corundum

A. A. MANENKOV AND A. M. PROKHOROV
P. N. Lebedev Institute of Physics, Academy of Sciences, SSSR

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THE paramagnetic resonance of chromium slats has been studied mostly in alums. The crystalline electric field, acting on a chromium ion in these combinations, has trigonal symmetry, and creates the splitting of two Kramers spin doublets (in the absence of an external magnetic field) in the interval from 0.12 to 0.18 cm^{-1}, depending on the type of alum [1].

We have investigated the spectrum of the paramagnetic resonance in a strong solution Al_2O_3- Cr_2O_3 (chromium corundum), at a chromium concentration of 0.05%. Earlier, this combination was investigated by Kashaev [2]; however, the author failed to explain the spectrum observed by him. We investigated the above-named combination at two frequencies, ν_1= 11970 mc/sec and ν_2=8960 mc/sec, at room temperature.

Chromium corundum represents a uniaxial crystal. When the axis of symmetry of the crystal is parallel to the direction of the applied external magnetic field, a fine structure of the spectrum of paramagnetic resonance is observed, consisting of three lines, which correspond to an electronic spin of Cr^{3+} equal to 3/2. At the frequency ν_2 =8960mc/sec. two of the observed lines are due to the magnetic dipole transitions $M = 3/2 \leftrightarrow 1/2$, and one of the lines is due to the transition $M = 1/2 \leftrightarrow -1/2$. The transition $M = -3/2 \leftrightarrow -1/2$ is not observed at this frequency, since the initial splitting of the levels $M = \pm 1/2$ and $M = \pm 3/2$, created by the internal crystalline electric field, is greater than $h\nu_2$. At the frequency ν_1 = 11970 mc/sec the observed lines of the fine structure are due to the transitions

$$M = {}^3/_2 \leftrightarrow {}^1/_2, \quad M = {}^1/_2 \leftrightarrow -{}^1/_2,$$
$$M = -{}^3/_2 \leftrightarrow -{}^1/_2.$$

When the axis of symmetry is perpendicular to the direction of the external magnetic field, two lines are observed at the frequency ν_2 =8960mc/sec, and four lines at the frequency ν_1 =11970 mc/sec. Here in agreement with theory, the relative intensity of the lines depend on the angle between the axis of symmetry of the crystal and the direction of the radiofrequency field.

Assuming that the chromium ion is acted on by an electric field with trigonal symmetry, the observed spectrum may be described with the aid of the following Hamiltonian [1].

$$\hat{H} = D[\hat{S}_z^2 - {}^1/_3 S(S+1)] + g_{\parallel}\beta H_z \hat{S}_z + g_{\perp}\beta(H_x\hat{S}_x + H_y\hat{S}_y),$$

where D is a constant characterizing the splitting of the levels in the crystalline electric field, S is the electron spin, $\hat{S}_x$, $\hat{S}_y$, $\hat{S}_z$ are the components of the spin operator, g_{11} and $g_{\perp}$ are spectroscopic splitting factors corresponding to parallel and perpendicular orientation of the crystal with respect to the external magnetic field, β is the Bohr magneton, and H_x, H_y, H_z are the components of the magnetic field intensity.

The initial splitting of the spin levels in the absence of the magnetic field $|2D|$, was found to be 0.3824 cm^{-1}, which exceeds the splitting in alum by more than a factor of two. The g-factors are, $g_{\parallel}$ = 1.984 ±0.0006; $g_{\perp}$=1.9867 ±0.0006.

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The Radiation of CO_2 in the Region of 15μ in an Electric Discharge

N. IA. DODONOVA AND V. V. SOBOLEV
Leningrad State University

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THE investigation of radiation from electric discharge through CO_2 in the region of 15