obtained dependences of the lifetime on the temperature and on the photoexcitation level, at the used impurity concentrations are not connected with inter-impurity recombination [6] and are not determined by the capture of electrons by the neutral boron [2]. The low concentration of the free carriers ($\lesssim 10^9$ cm^{-3}) excludes interband radiative, exciton, and Auger recombination. The experimental data point to the presence of a shallow recombination level due to boron, and are explained by the proposed mechanism of recombination via A^+ centers (see Fig. 2). At high temperatures, when the concentration of the A^+ centers is small because of the intense reemission of the captured holes, the recombination procedes via deep centers [7]. With decreasing temperature and increasing photoexcitation level, the concentration of the A^+ centers increases and the boron begins to exert a noticeable influence on the recombination process. A calculation carried out on the basis of the proposed model gives for τ_n and τ_p dependences on the temperature and on the illumination level that are close to the experimental ones, if the coefficient of capture of the hole by the neutral acceptor is set equal to $\alpha_p^0 = 10^{-7}$ cm^{3}sec^{-1}, the coefficient of capture of an electron by an A^+ center is $\alpha_n^+ = 5 \times 10^{-6}$ cm^{3}sec^{-1}, and the binding energy of the hole with the neutral boron is $\varepsilon_i = 5$ meV.

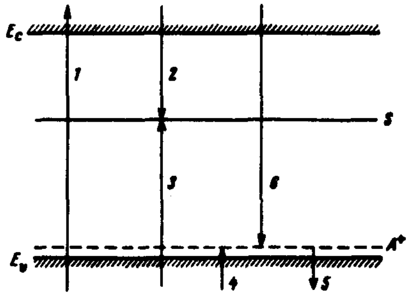

Fig. 2. S - deep level, A^+ - level of A^+ center, 1 - interband excitation of carriers, 2, 3 - capture of electrons and holes by deep centers, 4, 5 - capture of holes by neutral boron and their re-emission, 6 - capture of electrons by A^+ centers.

Analogous experiments were performed by us on n-Ge, p-Ge, and n-Si. The influence of the considered recombination mechanism in these materials comes into play at lower temperatures than in Si:B. This agrees with the fact that these substances are characterized by lower values of ε_i, as measured by us directly in [8].

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OBTAINING THE "SINGLE-Q" STATE OF CHROMIUM BY ACTION OF LOW TEMPERATURES IN THE PRESENCE OF A MAGNETIC FIELD

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As is well known [1, 2], the "single-Q" state of chromium, characterized by the presence in the sample of antiferromagnetic domains with one modulation of the spin-density waves, is produced when the single crystal is cooled through the Neel point (T_N) in a strong magnetic field (cooling field - H_0) directed along a chosen wave vector $\vec{Q}_i$ (i = x, y, z) coinciding with one of the principal axes of the cube.

It is shown in the present paper that the "single-Q" state can be obtained by another more effective method. To this end, it suffices to subject a chromium crystal to single cooling from room temperature to nitrogen temperature in the presence of a strong magnetic field. The efficiencies of both methods were compared using the same sample of iodide chromium with a pronounced anisotropy [3].

The state of the magnetic structure of the crystal was monitored by the neutron diffraction method (λ = 1.25 Å) against the intensities of the satellites (0.1 - δ, 0) and (0, 0, 1 - δ) at room temperature in the absence of a magnetic field. The accuracies with which the reflections and the magnetic field were measured were approximately 10 and 2%, respectively.

Figure 1 shows curves that enable us to estimate the degree of transition of the sample to the "single-Q" state as a function of the applied magnetic field.

Before determining each point, the crystal was returned to the initial "triple-Q" state by heating above T_N. The ordinates represent the ratios of the intensities of the reflections of suppressed modulation (I_{Q_s}) to the intensity of the satellites of the chosen modulation (I_{Q_c}). Plots 2 and 3 were obtained by the method of magnetic-low-temperature treatment at constant cooling temperature 77°K, and plots 1 and 4 by the standard method. Plots 1 and 2 give a ratio I(0, 1 - δ, 0)/I(0, 0, 1 - δ) at $H\uparrow\uparrow\bar{Q}_z$ and a transition of the crystal to the "single-Q_z" state, while 3 and 4 give the opposite ratio at $H\uparrow\uparrow\vec{Q}_y$ and a

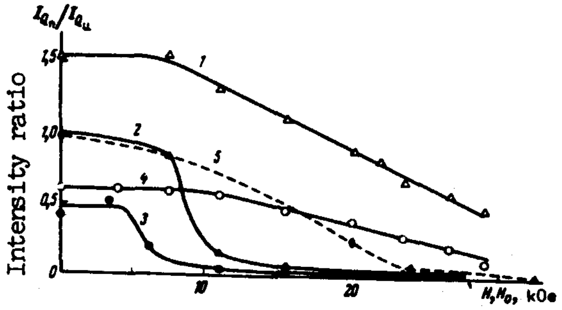

Fig. 1

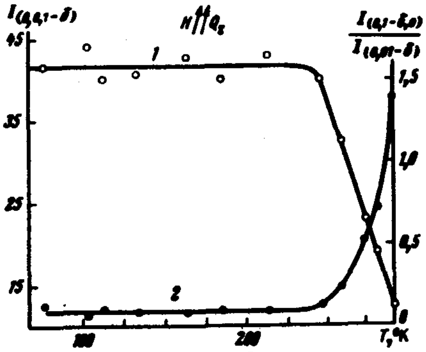

Fig. 2

Fig. 1. Dependence of the transition of a single crystal from the "triple-Q" to the "single-Q" state on H and H_0 at a constant value of the low-temperature factor: 1 - I(0, 1 - δ, 0)/I(0, 0, 1 - δ); $H_0\uparrow\uparrow\bar{Q}_y$; 2 - I(0, 1 - δ, 0)/I(0, 0, 1 - δ); $H\uparrow\uparrow\bar{Q}_z$; 3 - I(0, 0, 1 - δ)/I(0, 1 - δ, 0); $H\uparrow\uparrow\bar{Q}_y$; 4 - I(0, 0, 1 - δ)/I(0, 1 - δ, 0); $H_0\uparrow\uparrow\bar{Q}_y$; 5 - I(1 - δ, 0, 0)/I(0, 1 - δ, 0); $H_0\uparrow\uparrow\bar{Q}_y$ [4].

Fig. 2. Temperature dependence of the intensity of the reflection (0, 0, 1 - δ) (curve 1) and of the ratio I(0, 1 - δ, 0)/I(0, 0, 1 - δ) (curve 2) in the presence of H = 15.5 kOe.

transition to the "single-Q_y" state. The difference between the zero points of curves 1 and 2 or 3 and 4 is due to the effective temperature hysteresis. The figure shows also for comparison a plot (curve 5) of the transition to the "single-Q" state of the single crystal of Werner et al. [4], plotted from the tabulated data.

The influence of the temperature factor on the realignment of the magnetic state of the crystal during the process of the magnetic-low-temperature treatment is shown (Fig. 2) on the temperature dependence of the intensity of the reflection $(0, 0, 1 - \delta)$ and the ratio $I(0, 1 - \delta, 0)/I(0, 0, 1 - \delta)$ at a constant value of the previously applied field 15.5 kOe, directed along $\vec{Q}_z$. We see that the cooling factor produces an influence only up to 230°K.

As follows from plots 2 and 3 (Fig. 1) and the curves of Fig. 2, we apparently succeeded in effecting, below room temperature, a realignment of the antiferromagnetic lattice of the crystal from the "triple-Q" to the "single-Q" state by the joint influence of the magnetic fields and low temperatures, i.e., by a new method. Comparisons of the observed fraction of the residual modulation in the "single-Q_z" and "single-Q_y" states of the sample, produced by two methods, at $H = 27.5$ kOe, first confirmed the difference between the critical fields of the transition to the "single-Q" state for each $\vec{Q}_j$ [5], and, second indicate that the magnetic-low-temperature treatment of the crystal is more effective in the attainment of the complete "single-Q" state than the classical method of cooling in H_0 through T_N.

In all cases when the stability of the "single-Q" state was monitored for a day, the magnitude of the reflection $(1 - \delta, 0, 0)$ did not exceed the limits of the measurement error. However, in a single observation of the "single-Q" state of a sample with 9% contribution of the modulation of Q_y, carried out after two weeks, a 25% decrease of the intensity of the reflection $(0, 0, 1 - \delta)$ and an opposite change in the satellite $(0, 1 - \delta, 0)$ were observed, thus confirming the possibility of spontaneous redistribution of the volume of the sample at room temperature among domains with different modulation of the spin-density waves [6].

The "single-Q" state of the crystal, obtained by the method of magnetic-low-temperature treatment, is also completely destroyed by heating above the T_N.

Whereas the mechanism of formation of the "single-Q" state of a sample in a field by cooling through T_N reduces apparently to a simple suppression of the growth nuclei of the domains with $\vec{Q}_i \perp H_0$ and assurance of a preferential growth of the domains with $\vec{Q}_i \uparrow\uparrow H_0$, the transition of the crystal from the "triple-Q" to the "single-Q" state under the influence of the magnetic-low-temperature treatment is accompanied by a radical realignment of the lattice in the greater part of the sample. The state of the spin as a result of large simultaneous temperature and magnetic actions cannot be interpreted on the basis of the available data alone, but it can be assumed that in the processes of the change of direction of the polarization and "switching" of the wave vectors, the latter is the resultant process.

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VIRTUAL EXCITATION OF NUCLEON ISOBARS IN NUCLEI AND REACTIONS OF QUASIELASTIC "KNOCKOUT" OF ISOBARS OF HIGH ENERGIES

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The role of nucleon resonances (isobars) in the description of nuclear properties and interactions was discussed earlier in connection with the calculation of the nucleon-nucleon potential [1, 2], the binding energy of nuclei [3], electromagnetic [4] and weak [5] coupling constants, and also in connection with a description of certain nuclear reactions [6, 7].

The purpose of the present article is to propose a new method of experimentally verifying the existence of isobars in nuclei on the basis of a study of the formation of isobars in reactions where high-energy hadrons interact with nuclei.

Let us list first certain experimental facts pertaining to the isobar-production reactions [8, 9]

$$\text{hadron} + N \to \text{hadron} + N^* (\Delta), \tag{1}$$

and which will serve as a basis for subsequent analysis.

1. The cross sections for the production of N*-isobars with isospin I = 1/2, namely N*(1420), N*(1520), and N*(1690), vary slowly with increasing energy in πN and NN reactions of type (1), and the cross section for formation of Δ(1238) with isospin I = 3/2 decreases rapidly (approximately like E_{lab}^{-1}, where E is the energy of the incident particle).

2. The cross sections for the production of N*-isobars at zero angle are small compared with the cross section for elastic scattering

$$\frac{d\sigma(N(\pi) + N \to N(\pi) + N^*)}{d\sigma(N(\pi) + N \to N(\pi) + N)} \approx 10^{-2}. \tag{2}$$

3. The diffraction-cone slopes

$$B = \frac{d}{dt}\left(\ln \frac{d\sigma}{dt}\right)\Bigg|_{t=0}$$

for πN and NN reactions of type (1) satisfy the relation

$$B(N^*(1420),\ \Delta(1238)) : B_{el} : B(N^*(1520),\ N^*(1690)) = 2:1:0.6. \tag{3}$$

Let us consider now the formation of isobars in interactions of hadrons with nuclei.

One can expect virtual excitation of the isobars to occur, with a certain probability, in the bound state of the nucleus, i.e., the nucleons and the nucleon resonances can be regarded as "partons," making up the nucleus. The interaction of the incident hadron with the nucleus is determined by the interaction with all the "partons" of the nucleus. Obviously, the mechanism of