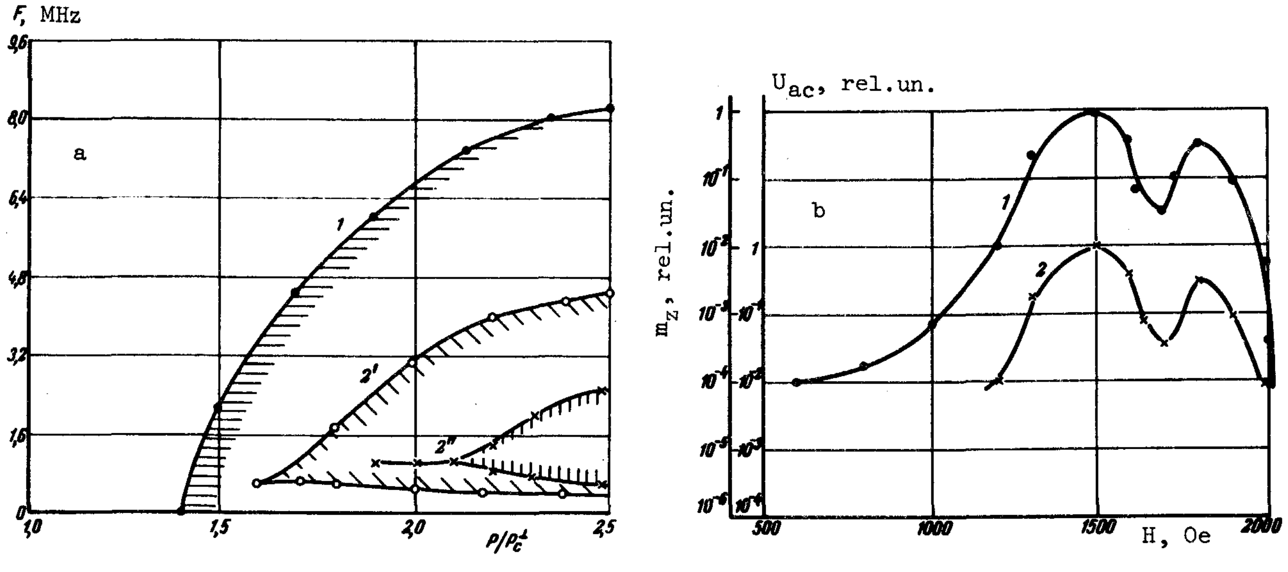

Fig. 2. a) Spectral composition of NFMR auto-modulation oscillations (1) and of acoustic oscillations (2) (2', 2" - piezoelectric plates with resonant frequencies ∿500 kHz and ∿1 MHz respectively, P_c - minimum NFMR excitation threshold for transverse pumping). b) Intensity curves of NRMR auto-modulation (1) and of the acoustic oscillations (2).

modulation is accompanied by excitation of ultrasonic acoustic oscillations were observed also in hematite (α-Fe_2O_3) at room temperature. In this case the intensity of the acoustic oscillations is higher by more than one order of magnitude than the intensity in the yttrium ferrite.

[1] Ya. A. Monosov, Zh. Eksp. Teor. Fiz. 51, 222 (1966) [Sov. Phys.-JETP 24, 149 (1967)].
[2] V. I. Zubkov and Ya. A. Monosov, PTE 13, 1897 (1968).
[3] A. V. Vashkovskii and Ya. A. Monosov, ibid. 12, 1392 (1967).
[4] I. E. Dikshtein, Ya. A. Monosov, and V. V. Surin, Fiz. Tverd. Tela 10, 1907 (1968) [Sov. Phys.-Solid State 10, 1506 (1968)].

YIELD OF DEUTERONS KNOCKED OUT FROM THE C^{12} NUCLEUS BY 730 AND 1260 MeV PROTONS

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The yield of deuterons from the C^{12} nucleus near the maximum of backward elastic p-d scattering was investigated on the internal target of proton synchrotron of the Institute of Theoretical and Experimental Physics. The experimental setup is shown in Fig. 1. The particles emitted at an angle of 13° to the direction of the primary beam were momentum-analyzed by an SP-12 magnet and were incident on a scintillation-counter hodoscope C_1 - C_6 with a flight base 16.6 m, where the deuterons were separated from the other particles by their time of flight. The setup and the experimental procedure are described in detail in [1]. We used a carbon target 0.5 mm thick. The measurements were made at two kinetic ener-

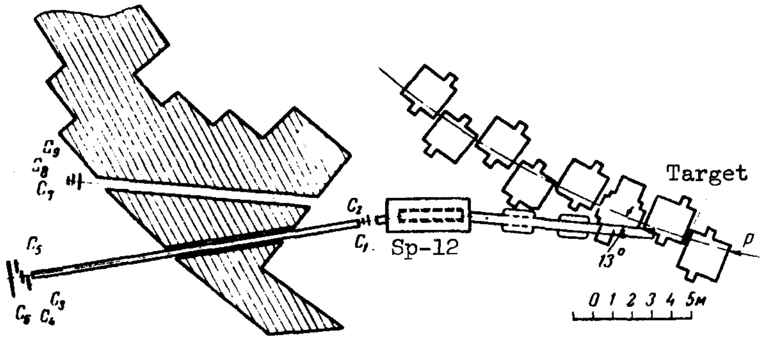

Fig. 1. Diagram of experimental setup.

gies of the incident protons, T_0 = 730 MeV and T_0 = 1260 MeV. The momentum resolution of the setup was 5.6% at T_0 = 730 MeV and 2.8% at T_0 = 1260 MeV (these values include the resolution of the magnetic spectrometer and the momentum spread of the primary beam, and take into account the multiple scattering of the secondary deuterons in the matter in the path of the beam).

The experimental spectra are shown in Figs. 2a (T_0 = 730 MeV) and 3a (T_0 = 1260 MeV), where the abscissas represent the deuteron momentum p_d, and the ordinates the differential deuteron-emission cross section per unit solid angle and per unit deuteron-momentum in-

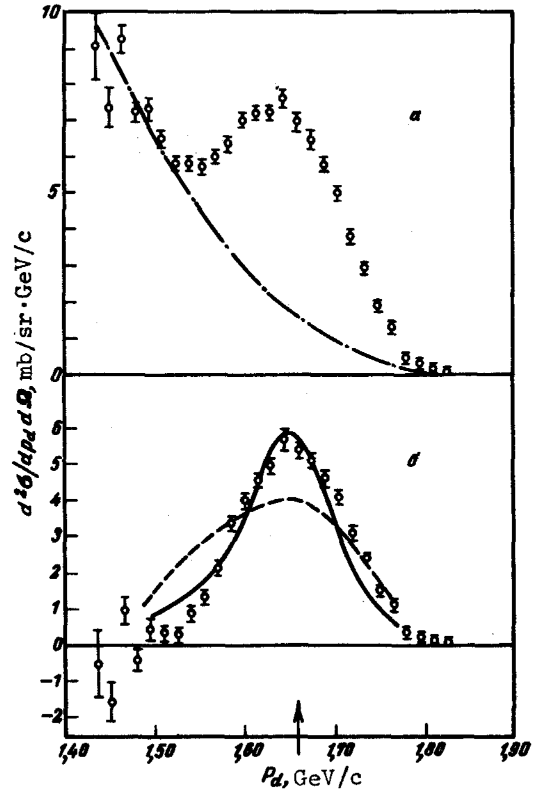

Fig. 2

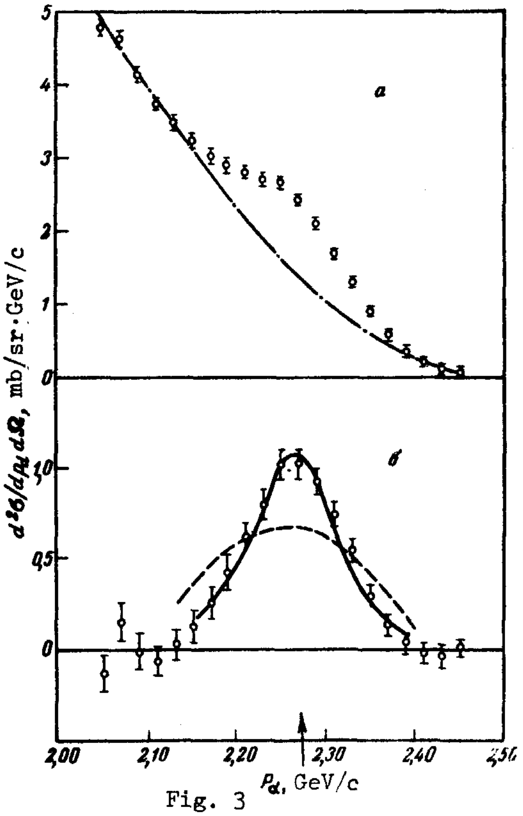

Fig. 3

Fig. 2. Deuteron spectra at T_0 = 730 MeV: a - summary spectrum, b - spectrum of inelastic deuterons.

Fig. 3. Deuteron spectra at T_0 = 1260 MeV: a - summary spectrum b - spectrum of inelastic deuterons.

terval. The arrows on the figures show the momenta of the deuterons from the elastic backward p-d scattering reaction. The observed irregularity of the spectrum near the backward elastic p-d scattering shows the quasielastic deuterons are knocked out of the C^{12} nucleus by the incident protons.

It follows from the experimental data that there exists a deuteron background that falls off smoothly with increasing momentum. The presence of experimental points on both sides of the quasielastic maximum on Figs. 2a and 3a allows us to draw a smooth background line and separate the quasielastic deuterons. The background curves are in Figs. 2a and 3a by dash-dot lines. The momentum dependence of the differential cross section for the emission of quasielastic deuterons, obtained after substracting the background, is shown in Figs. 2b and 3b. We were unable to exclude by means of the described procedure the cases in which the final nucleus disintegrated or became excited, since we registered only the deuterons.

An analysis of the obtained momentum spectra of the quasielastic deuterons was performed from the point of view of the direct nuclear reactions. We considered a pole diagram with the deuteron as the virtual particle, and assumed that the produced B^{10} nucleus is in ground state. The finite dimensions of the nucleus were taken into account by introducing the Butler form factor

$$f(q) = \cos qR + \frac{k}{q} \sin qR$$

in the nuclear vertex. Calculations similar to those of [2] lead to the following expression for the differential cross section:

$$\frac{d^2\sigma}{d\Omega_d\, dp_d} = \frac{27 m_p \theta^2}{2\pi R p_p} \left(\frac{d\sigma_p}{d\Omega}\right) \frac{p_d^2}{\sqrt{(p_d^2 + m_d^2)(p_p^2 + p_d^2 - 2 p_p p_d \cos\theta_{pd})}} \times$$
$$\times \int_{g_{min}}^{g_{max}} \frac{|f(q)|^2}{g^2 + k^2} g\,dq,$$

where p_p, m_p, and p_d, m_d are the momentum and mass of the incident proton and the emitted deuteron, respectively, q is the modulus of the momentum of the residual B^{10} nucleus (all the momenta are in the lab. system), θ^2 is the reduced deuteron width of the initial C^{12} nucleus, R is the radius of the $C^{12} \rightarrow B^{10} + d$ channel,

$$k^2 = 2 m_B m_d\, \varepsilon / m_B + m_d\ ,$$

ε is the binding energy of the deuteron in the C^{12} nucleus, $d\sigma_0/d\Omega$ is the cross section for elastic backward p-d scattering in the lab. system at the same $\theta_{lab} = 13°$, taken from [1], and θ_{pd} is the angle between the incoming proton and the emitted deuteron. Expressions for g_{min} and g_{max} are given in [3].

The momentum spectra calculated by the foregoing formula do not take the resolution of the apparatus into account. To compare them with experiment, it is necessary to take into account the real $\Delta p/p$. The results of such a calculation are shown in Figs. 2b and 3b, where the solid curves are the momentum distributions obtained with allowance for the form factor, and the dashed ones are without this allowance. The theoretical curves of Figs. 3a and 3b are normalized, for the sake of clarity, to yield the same value of $d\sigma/d\Omega_d$ as the experimental spectrum. The figures demonstrate the good agreement between the experimental data and the solid curves, showing that the calculation of the form of the deuteron spectrum under the indicated assumptions is valid.

Using the expression for the differential cross section, we calculated on the basis of the experimental data the deuteron widths for both initial proton energies:

$$\theta^2 = 3{,}8 \pm 1{,}0 \text{ for } T_0 = 1260 \text{ MeV and}$$
$$\theta^2 = 2{,}7 \pm 0{,}7 \text{ for } T_0 = 730 \text{ MeV.}$$

The error in the determination of θ^2 contains, besides the statistical errors, also the inaccuracies in the determination of the absolute cross sections (∿20%) and the uncertainty resulting in the calculation of the spectrum (∿15%). The agreement between the reduced deuteron widths, at different values of the incoming proton energy within the limits of the experimental errors, confirms the validity of using the pole diagram for the process under consideration.

We note for comparison that $\theta^2 = 4.7 \pm 1.0$ for the O^{16} nucleus (this was obtained in [2] by reduction of the experimental data of [4]).

As indicated above, the excited levels of the final nucleus are not separated in the experiment. Nor are cases separated in which the final nucleus disintegrates. The obtained values must therefore be regarded as certain summary widths for the indicated transitions.

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[1] N. G. Birger, V. S. Borisov, G. K. Bysheva, L. L. Gol'din et al., Yad. Fiz. 6, 344 (1967) [Sov. J. Nuc. Phys. 6, 250 (1968)].
[2] V. M. Kolybasov and N. Ya. Smorodinskaya, ZhETF Pis. Red. 8, 335 (1968) [JETP Lett. 8, 206 (1968)].
[3] I. S. Shapiro and V. M. Kolybasov, Nucl. Phys. 49, 515 (1963).
[4] R. J. Sutter, J. L. Friendes, H. Palevsky, et al. Phys. Rev. Lett. 19, 1189 (1967).

MAGNETOCALORIC EFFECT IN RARE-EARTH IRON GARNETS

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We measured the magnetocaloric effect $\Delta T(H)$ in rare-earth iron garnets of Gd, Tb, Dy, Ho, Er, Yb, Tu, and also in yttrium iron garnet.

The ΔT effect is an energy characteristic, and its study can therefore yield added information concerning the magnetic structure and exchange interactions in rare-earth iron