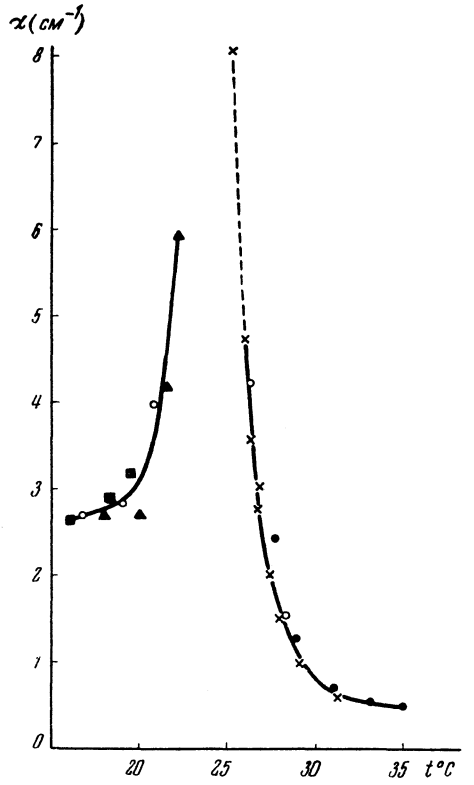
The measured temperature dependence of the amplitude coefficient of absorption of sound α is shown in the Figure. The dotted part of the curve corresponds to a temperature region in which the measurements were only approximate. These results show that the anomalous absorption of sound in a second-order phase transition predicted in a general way by Landau and Khalatnikov does indeed occur in solids,* although the case which we investigated was not specifically taken into account in their work.



It turns out from our experiments that in a ferroelectric substance this phenomenon has its own characteristic features: a transverse sound wave of given polarization undergoes an anomalous absorption; this absorption increases in both phases as their temperatures approach the λ-point. These circumstances have already been explained theoretically by Landau, whose results will, with the permission of the author, be set forth in another more detailed report.

In conclusion it is interesting to note that in a paper (of which Landau and Khalatnikov were unaware) by Huntington[3] devoted to measurements of the elastic constants of various substances by an ultrasonic method, the author describes an observation which now becomes completely understandable. While not citing systematic data for the absorption of sound at different temperatures, Huntington reported, however, that with the apparatus at his disposal it was not possible for him to work with Rochelle salt at temperatures below 26.5°C because of the strong absorption of sound in this crystal. It is now clear that Huntington's observation was related to experimental conditions corresponding to the steep rise of the upper part of the right-hand branch of our curve showing the temperature dependence of α.

Finally, it is perhaps necessary to include within this same set of phenomena the jump in the coefficient of absorption of sound in tin at temperatures near 160°C, observed by Bordoni and Nuovo[4]. Unfortunately the brevity of their report and the absence of quantitative data in it make it difficult to interpret their results, so much more so since the nature of this phase transition in tin is apparently still not completely clear.

The authors are extremely grateful to Academician L. D. Landau for valuable discussions of the results of their experiments.

*This was shown for the phase transition in liquid helium by Pellam and Squire[2].

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Translated by W. M. Whitney
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Nuclear Interaction in a Photoemulsion at an Energy of 8×10^{13} ev

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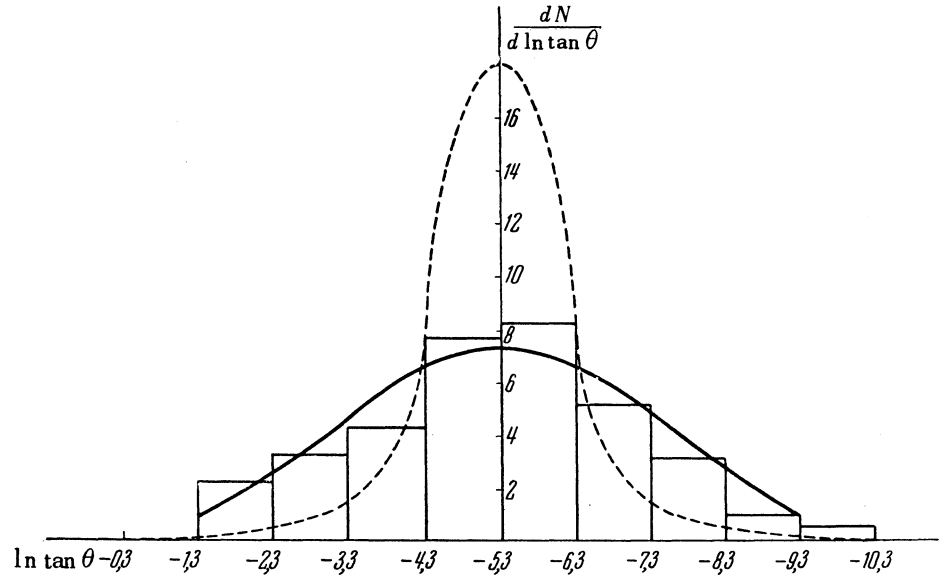
(Received by JETP editor January 12, 1957)
J. Exptl. Theoret. Phys. (U.S.S.R.) 32, 936-938 (April 1957)

IN A STACK of unmounted pellicles, Ilford type G-5, 600μ thick (P stack), irradiated in 1955 in

the Po valley at a height of 25.5 km for 6 hours, a nuclear interaction of the type $1 + 37\alpha$ was found, in which the secondary particles of the shower traverse 6 cm of path before leaving the stack.

1. The angular distribution of secondary charged particles was measured, the small angles θ being measured from the center of axial symmetry of the narrow cone of particles. To get the angular distribution of the penetrating particles directly in the center-of-mass system of the colliding nucleons, the angular variable was taken as $\ln \tan \theta$. The differential angular distribution, obtained by averaging three independent measurements, is shown in the figure.



A necessary condition for the determination of the original energy from the angular distribution is the symmetry of this distribution in the center-of-mass system relative to the angle $\theta_0 = \pi/2$. To test the symmetry the so-called χ^2-test[1] was used. It turned out that the experimentally observed angular distribution was symmetric with a probability of 90%.

Similarly, the probability of agreement of the experimental data with the assumption of an isotropic angular distribution (dotted curve in the figure) is about 0.1%, and the distribution predicted by Landau's[2] theory (solid line in the figure) is correct to a probability of about 90%.

Starting with the symmetry of the angular distribution we got several partially independent determinations of the energy E_c from the values of $\ln \tan \theta$ for each pair of particles symmetric about the angle $\theta_{1/2}$. As a result, for the energy of the original particle in the center-of-mass system (E_c) and in the laboratory system (E_0) we got:

$$E_c = \left(200^{+50}_{-40}\right) Mc^2, \quad E_0 = \left(8^{+4}_{-3}\right) \cdot 10^{13} \text{ ev per nucleon.}$$

The relatively small number of generations of fast particles, and likewise the presence of only one slow particle, lead to the assumption that only one out of four incident nucleons took part in the interaction, as has been observed frequently in the work of Rao and others[3].

2. In the summed path lengths of the secondary particles in the emulsion, about 110 cm, three cases of secondary interaction were found, the characteristics of which are given in Table 1, where, along with the energy, we also determined the transverse momenta of the particles (in the Table

$$\gamma_c = \exp\{\overline{\ln \tan \theta}\}, \quad \varepsilon_0 = 2\gamma_c^2 f(2)$$

where $f(l)$ is a correction taking account of the possibility of collision with several nucleons of the nucleus). In determining the energy of the secondary particles from the angular distribution of the showers formed by them, account was taken of the possibility of the simultaneous interaction of the incident particle with several (l) nucleons of a nucleus of the photoemulsion (see for example Ref. 4). A third interaction occurred near the axis of a

shower and was caused, probably, by a fragment of a primary α-particle (p, d or t).

TABLE 1.

Angle θ between secondary particle and shower axis	Type of secondary interaction	γ_0	ε_0 Bev	$\frac{p_\perp}{\mu c} = \frac{\varepsilon_0 \theta}{\mu c}$
$3 \cdot 10^{-3}$	$9+13$ p	5.5 ± 1.5	180^{+120}_{-90}	$3.9^{+2.7}_{-1.8}$
$6 \cdot 10^{-4}$	$3+10$ p	13 ± 4	700^{+500}_{-400}	$3^{+2.3}_{-1.8}$
$\sim 3 \cdot 10^{-4}$	$1+(10 \div 15)$ p	~ 200	$10^4 \div 10^5$	<200

3. Another indirect method for the approximation measurement of the transverse momenta ($p_\perp^0$) of the shower particles is the determination of the energy and direction of flight of the photons arising from the decay of π^0-mesons. Table 2 gives the characteristics of all the pairs, which, as far as we can tell, are not connected with electron brehmstrahlung. The table gives all the information needed for

TABLE 2.

α	s, мм	$h\nu$, Bev	$\theta_{\gamma x}$	$p^0_{\perp x}/\mu c$	t
$1 \cdot 10^{-4}$	4.5	130	$1 \cdot 10^{-3}$	1.8	0.35
$1 \cdot 10^{-4}$	4.5	130	$1 \cdot 10^{-3}$	1.8	0.35
$3.5 \cdot 10^{-4}$	2.7	30	$2 \cdot 10^{-3}$	0.8	0.35
$2.5 \cdot 10^{-4}$	2.1	40	$2 \cdot 10^{-3}$	1.2	0.43
$1 \cdot 10^{-4}$	4.6	130	$0.6 \cdot 10^{-3}$	1.2	0.55
$2 \cdot 10^{-4}$	2.2	90	$1.4 \cdot 10^{-3}$	1.8	0.55
$4 \cdot 10^{-4}$	1.2	25	$0.7 \cdot 10^{-3}$	0.25	0.67
$1.2 \cdot 10^{-4}$	6.0	110	$0.3 \cdot 10^{-3}$	0.6	0.8
$0.9 \cdot 10^{-4}$	5.8	160	$0.2 \cdot 10^{-3}$	0.5	0.8

Note: $\theta_{\gamma x}$ is the direction of the photon relative to the axis. $p_\perp^0$ is the x-component of the momentum; t is the distance from the point of formation of the shower in radiation lengths.

calculating $p_\perp^0$. The energy $h\nu$ of the photon was obtained from the relation:

$$h\nu = (4 m_e c^2 / \alpha) \sqrt{\log^2 \left(\frac{h\nu}{m_e c^2} \right) + 5s} \qquad (1)$$

where $m_e c^2$ is the rest energy of the electron and α is the angle of divergence of the components of the pair, measured by the value of their mutual separation in a path s (in mm). Since Eq. (1) gives the energy $h\nu$ under the assumption that the energies of the electron and positron are equal, it gives low values of $h\nu$ in the mean.

As can be seen from Tables 1 and 2, the values of the transverse momenta, measured by the two independent methods, agree satisfactorily with one another, and give a mean value $\bar{p}_\perp \sim 2\mu c$ with a scattering $\overline{\Delta p_\perp} \sim \bar{p}_\perp$ about the mean. This result agrees well with the corresponding data[5] obtained from direct measurement of the angles and energies of the secondary particles.

As is shown in Ref. 6, the distribution of the particles relative to the value of $p_\perp$ is such that it can be considered the result of purely thermal motion of the nascent particles.

The authors thank Prof. C. F. Powell for his cooperation in getting the emulsion stack, Prof. N. A. Dobrotin, I. L. Rozental' and D. S. Chernavskii for a discussion of the results, and laboratory Iu. F. Sharapov, R. M. Gryzumov and M. F. Solov'ev for their assistance in working up the materials.

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Translated by C. V. Larrick
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Paramagnetic Absorption in Some Manganese Salts in Parallel Fields at Super-High Frequencies

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(Submitted to JETP editor Jan. 14, 1957)
J. Exptl. Theoret. Phys. (U.S.S.R.) 32, 938-939
(April, 1957)

EARLIER,[1,2] WE MEASURED the paramagnetic absorption in some powdered salts of gadolinium and of manganese in parallel fields, at room temperature, at frequencies of the order of 9×10^9 cps. It was found that, as in the case of frequencies of the order of 6×10^8 cps,[3,4] the absorption decreases monotonically with increase of the constant magnetic field. The experimental absorption curves obtained in Ref. 1 to 4 are in good agreement with Shaposhnikov's[5] phenomenological theory of paramagnetic absorption in parallel fields, if it is assumed that the spin relaxation time τ_s of that theory is independent of the value of the constant field.

Recently, Smits *et al.*[6] experimentally established a more complicated type of dependence of paramagnetic absorption on the value of the constant field and on the frequency of the alternating field at temperature 20.4° K, for frequencies of order 10^6 to 10^8 cps. It was found, in particular, that the curves of absorption *vs* value of the constant field, at a given frequency of the alternating field, have a maximum.

The present note communicates the results of measurements of paramagnetic absorption in parallel fields in the powdered salts $Mn(NO_3)_2 \cdot 6H_2O$ and $Mn(NH_4)_2(SO_4)_2 \cdot 6H_2O$ at room temperature ($T = 291°$ K), at frequency $\nu = 9.377 \times 10^9$ cps. The method used in the measurements is that described in Ref. 1. The results of the measurements are presented in the Figure, where curves I and II relate respectively to the first and the second of the substances indicated above. Plotted along the ordinate axis is the imaginary part of the magnetic susceptibility in arbitrary units, and along the abscissa axis the value of the constant field, which is parallel to the high-frequency field. It is evident that the absorption curves for the salts under study differ essentially from those obtained earlier for other substances;[1,2] there is an absorption maximum in a range of constant fields of order 1500 oersted. Thus our results, which relate to room temperature, are similar to the results obtained by Smits *et al.*[6] at temperature 20.4° K. In the range of fields of order 3400 oersted, the absorption curves are somewhat irregular; apparently the reason for these irregularities lies in a paramagnetic resonance absorption, caused by a slight deviation from paral-