TABLE V

Element	σ $P = 3.5 \times 10^{12}$ bars	V_A, cm^3/g-atom		D, km/sec		$\rho_0 D^2 \cdot 10^{12}$ bars		ΔE 10^{10} erg/g
		$P = 0$	$P = 3.5 \cdot 10^{12}$ bars	$P = 0$	$P = 3.5 \cdot 10^{12}$ bars	$P = 0$	$P = 3.5 \cdot 10^{12}$ bars	$P = 3.5 \cdot 10^{12}$ bars
Fe	1.67	7.12	4.26	4.63	10.53	1.68	8.70	9.0
Cu	1.70	7.11	4.18	3.95	9.75	1.39	8.48	8.1
Zn	1.89	9.16	4.84	2.92	10.19	0.61	7.41	11.0
Ag	1.71	10.28	6.01	3.08	8.96	0.99	8.42	6.9
Cd	1.93	13.01	6.72	2.34	9.15	0.47	7.23	10.0
Sn	2.16	16.30	7.54	2.64	9.44	0.51	6.49	13.0
Au	1.59	10.22	6.43	2.98	6.99	1.71	9.43	3.3
Pb	2.21	18.27	8.25	1.91	7.5	0.41	6.38	8.0
Bi	2.27	21.32	9.39	1.85	7.99	0.33	6.25	10.0

S. N. Pokrovskii, A. L. Zhiriakov, M. M. Pavlovskii and V. P. Drakin.

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Note added in proof (March 10, 1958). The results obtained in the first experimental series also agree with the measurements of the dynamic compression of metals from 150,000 to 400,000 atm [Walsh, Rice, McQueen and Yarger, Phys. Rev. **108**, 196 (1957)], which were brought to the attention of the present authors after this paper was sent to press.

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SOVIET PHYSICS JETP VOLUME 34(7), NUMBER 4 OCTOBER, 1958

EXPERIMENTAL DETERMINATION BY AN OPTICAL METHOD OF THE STRESSES IN AN ANISOTROPIC PLATE UNDER THE ACTION OF A CONCENTRATED FORCE. II

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The state of stress in an anisotropic plate made of a 60% TlBr + 40% TlI single crystal of the cubic system was investigated by an optical method. The case of a concentrated force directed along the (110) direction is considered.

1. The present paper is a supplement to Ref. 1, in which an attempt at an optical method of the investigation of stress in anisotropic media was carried out. The theoretical bases of this method was set forth in Ref. 2, while a more detailed methodological instructions were given in Ref. 3. In Ref. 1, the problem of the effect of a concentrated force on an anisotropic plate cut from a single crystal of the alloy TlI + TlBr parallel to the plane of the cube was considered (the crystal belonged to the cubic system). The direction of the force coincided with the direction of the maximum of the modulus E, i.e., with the (100) direction.

According to the method given previously, the stresses at an arbitrary point of an anisotropic plate are determined from the formulas

$$\tan 2\beta = k \tan 2\varphi, \tag{1}$$

$$\delta = C_\beta d (\sigma_1 - \sigma_2), \tag{2}$$

where β is the angle determining the direction of the semi-axis of the optical ellipsoid and is measured from the (100) direction (the optical parameter of the isocline), φ = the angle defining the direction of the principal normal directions (elastic parameter of the isocline), δ = optical path difference of two rays propagated along the direction of the normal at a given point of the plate considered, $\sigma_1 - \sigma_2$ = difference of the principal normal stresses, k = coefficient equal to the ratio of the two constants A and B which define the photoelastic properties of the material, C_β = a coefficient depending on the angle β. Here, δ and β are quantities which are directly measured by experiment.

These formulas show that in the observation of the stress of an anisotropic plate in polarized light, the optical interference picture (as also the stress distribution) depends on the orientation of the direction of the applied forces relative to the crystallographic axes of the plate. The present research also had the purpose of showing experimentally the difference both in the interference picture and the stress distribution which is produced by a change in the orientation of the plate. Here we consider the same problem as in Ref. 1 — the effect of a concentrated force on the anisotropic plate, except that the direction of the applied force is that of the (110) direction i.e., the direction of the maximum modulus E.

2. The model investigated was prepared from a single crystal of an alloy of 40 mol percent TiBr + 60 mol percent TlI, which belongs to the group of "transparent metals."[4-5] According to Ref. 1, the photoelastic constants of the material of the model are equal to

$$A = +12\cdot 10^{-13}\ \text{cm}^2/\text{dyne},\quad B = -205\cdot 10^{-13}\ \text{cm}^2/\text{dyne},$$

and the elastic constants are

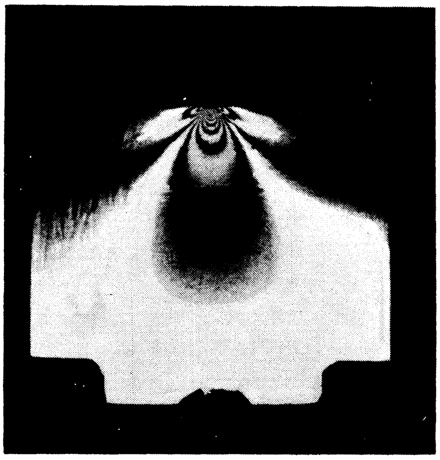

FIG. 1. Photograph of a picture of isochromes at a load P = 9.18 kgm.

$$S_{11} = 37\cdot 10^{-13}\text{cm}^2/\text{dyne},\ S_{44} = 182\cdot 10^{-13}\text{cm}^2/\text{dyne};$$

$$S_{12} = -11\cdot 10^{-3}\ \text{cm}^2/\text{dyne}.$$

The model was a rectangular plate of dimensions 40.5 × 34.0 × 4.15 mm. The plate was so cut that its plane coincided, and its side edges made an angle of 45°, with the plane of the cube, i.e., the side edges of the plate run along the (110) direction. Before the measurement, the plate was annealed at a temperature of 190°C to remove the remaining stresses obtained in its processing. For loading the model we made use of a special device, consisting of a stage on which was put a plate and a lever arm, by means of which (making use of a steel cylinder of diameter 2 mm, with its axis located perpendicularly to the plane of the plate) a concentrated pressure was produced on the center of the upper face of the model.

The loading system was put in a polarization apparatus so that rays fell on the model perpendicularly to its surface. Since it was necessary to photograph the entire model and, moreover, to measure the optical path difference δ at separate points of the model, two polarization setups were used: (1) a projection polarization unit (PPU) and (2) a cordinate synchronized polarimeter (KSP) which was prepared in the experimental workshop NIIMM of Leningrad State University. These two units were so set up that it was possible to use them without moving the loading system with the model from one place to another.

The direction of the force coincided with the (110) direction. In this case, it was more suitable to make the measurement of the angles from this direction. Therefore we introduced the angle $\gamma = \beta - 45°$, which changed the fundamental derived formulas to the following form:

$$\tan 2\alpha = k \tan 2\gamma, \tag{1'}$$

$$\delta = C_\gamma d(\sigma_1 - \sigma_2), \tag{2'}$$

where $\alpha = \varphi - 45°$ and C_γ has the value

$$C_\gamma = \frac{AB}{\sqrt{B^2 \sin^2 2\gamma + A^2 \cos^2 2\gamma}}. \tag{3}$$

The force acting on the model amounted to 4.8 kgm.

3. Figure 1 shows the isochromes obtained on the apparatus PPU for circular polarization and with an interference filter of mean wavelength λ_m = 610 mμ and transmission band width ± 12 mμ. If we compare the given picture of the isochromes with the picture of isochromes given in Fig. 1 of Ref. 1, it is seen how sharply the isochromes are changed in their dependence on the orientation of the plate. Here the pressure is produced in the direction of the largest values of the coefficient of photoelasticity C_β; there, the direction of the pressure coincided with the direction of the smallest value of C_β.

In addition to the photograph of the isochromes, we carried out measurements of the optical path difference over the horizontal cross section, located at a distance of 5 mm from the upper edge. In the method of measurement of the optical path difference with the aid of a compensator (measurement was carried out on the mica compensator of Krasnov[6]), there enters as a required element the measurement of the angle which determines the position of the plane of polarization of the ray propagated through the plate, i.e., the angle β, or, in our case, the angle γ. Thus, the optical quantities γ and δ were obtained at the points of the particular cross section.

On the basis of Eqs. (1′) and (2′), the quantities φ and $\sigma_1 - \sigma_2$ were calculated according to these data. Consequently, we obtain two quantities φ and $\sigma_1 - \sigma_2$ at any point of the model by the photoelastic method. For the complete solution of the problem, it is also necessary to obtain σ_1 and σ_2 separately. Usually, the method of numerical integration of the equilibrium equation is applied for the separation of the principal normal stresses, making use of data obtained optically. This method is also applied in the case of an anisotropic medium, since the equations of equilibrium are valid for every continuous medium. In this way we would obtain a complete solution of the problem, and for estimates of the roughness of the experiment we compare the data obtained with the theoretical solution. However, in our case, it was desirable to estimate the roughness of the measurement by those quantities which were obtained purely optically. Making use of the same method of numerical integration (which has its own roughness) we could not estimate the accuracy of the photoelastic method. Therefore, for such an estimate we employed a direct comparison of the obtained data with the theoretical data. The theoretical solution of the given problem[7] gives the following results:

(1) the stresses are radial, i.e., the angle α which determines the direction of the principal normal strain, is equal to the central angle θ;

(2) $\sigma_\theta = \sigma_{r\theta} = 0$; $\sigma_r \neq 0$, i.e., that σ_r and σ_θ are the principal normal strains, where $\sigma_r - \sigma_\theta = \sigma_r$;

(3) $\sigma_r r = \text{const}$ for $\theta = \text{const}$, i.e., the strain along the radius changes inversely proportionally to the radius.

These data make it possible to draw the following comparisons.

I. We compare the angle α, computed on the basis of the experimental data, with the angle θ. The data for the comparison are given in the Table, where x is the coordinate of the point measured from the direction of action of the force. The table

x*	θ°	α°
0	—	—
0.5	6	5
1.5	17	19
2.0	22	24
3.0	31	31
4.0	39	36
5.0	45	41
5.5	48	43
5.8	49	45
6.3	52	46
7.0	54	48

*x – coordinate of the point measured from the axis drawn through the direction of action of the force.

shows that there is satisfactory coincidence up to limits of 45°; beyond, there is observed a steadily increasing divergence which can be explained by the finite dimensions of the plate; the radial strains take place in an infinite medium. Detailed comparisons were also carried out on the other cross sections.

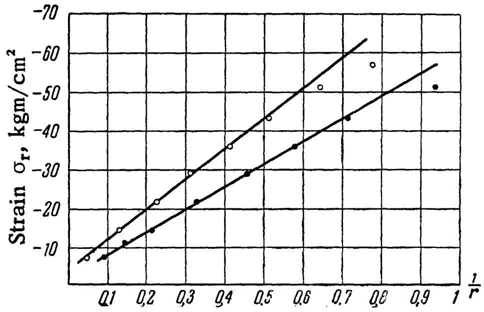

FIG. 2. Dependence of the strain σ_r on the distance for the direction $\varphi = 0$, ○ – P = 8.194, ● – P = 5.784 kgm.

II. Figure 2 shows a graph of the change of $\sigma_1 - \sigma_2$ in dependence on $1/r$. The graph shows that the points lie rather well along a straight line, which is also in agreement with theory.

III. Figure 3 shows: (1) a graph of the optical path difference δ, (2) the graph of $\sigma_1 - \sigma_2$, and (3) the graph of σ_2, constructed from theoretical data. All the graphs are given for the cross section h = 5 mm. Taking it into consideration that $\sigma_1 - \sigma_2 = \sigma_r - \sigma_\theta = \sigma_r$, we can state the excellent agreement of theoretical and experimental results.

IV. Figure 4 shows the curve $\sigma_r = \text{const}$, constructed from the theoretical data and the curve $\sigma_1 - \sigma_2 = \text{const}$ drawn from the experimental data, which also agree sufficiently well. On this same

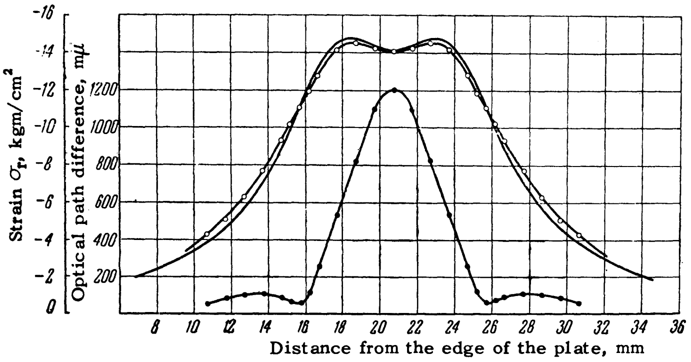

FIG. 3. Distribution of the strain σ_r for the load P = 5.784 kgm at the cross section h = 5 mm; continuous line – theoretical curve, o – experimental results, • – optical path difference.

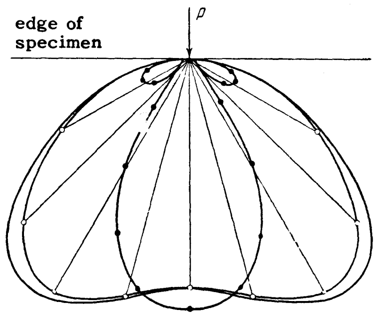

FIG. 4. Curves σ_r = const: continuous line – theoretical curve for $\sigma_r = 16.3$ kgm/cm² = const; o – experimental values for $\sigma_r = 16.3$ kgm/cm² = const; • – isochrome of the first order; P = 5.784 kgm.

curve, there is drawn one of the isochromes which shows clearly that the anisotropy of the photoelastic properties is sharply distinguished from the anisotropy of the elastic properties. In the case of an isotopic body, these curves coincide, as is well known. One must turn one's attention also to the fact that the maximum value of the radial strain σ_2 takes place not on the line of action of the force, but on the two rays located symmetrically relative to this line.

In conclusion, we consider it our pleasant task to thank A. L. Shakh-Budagov for his assistance in carrying out this research.

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STRANGE-PARTICLE DECAYS IN THE THEORY OF FEYNMAN AND GELL-MANN

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An explanation is given for the equal probabilities of the K_{e3} and $K_{\mu 3}$ decays in the absence of K_{e2} decay, and of the large asymmetry in the decays of polarized hyperons. The assumption used is that of a universal A — V interaction as proposed by Feynman and Gell-Mann.

ONE of the most interesting facts relating to the lepton decays of K mesons is the absence of the decay $K^+ \rightarrow e^+ + \nu$ and the presence of the decay $K^+ \rightarrow \mu^+ + \nu$, together with the approximately equal probabilities of the decays $K^+ \rightarrow \mu^+ + \nu + \pi^0$ and $K^+ \rightarrow e^+ + \nu + \pi^0$.

We would like to point out that these facts can be explained in an altogether natural way if one