Fig. 1. Fermi plot of the momentum spectrum of Cu^{61} positrons. The extrapolated end point is at $W_0 = 3.36$ mc², corresponding to 1.205 Mev. The deviation from the theoretical straight line begins at $W = 2.0$ mc².

value obtained by Bradt et al.,[3] and considerably higher than the value shown in the Segrè chart.[4]

As in the case of Cu^{64}, a large deviation from the Fermi theory is observed at low energies. In this case, the excess of positrons appears for all energies below $W = 2.0$ mc².

In Fig. 2 we have plotted the ratio of the experimental number of positrons per unit momentum interval to that predicted by the theory as a function of the energy, W. The data for Cu^{64} are shown for comparison.

Since Cu^{61} and Cu^{64} have the same nuclear charge, Z, it would appear that the difference in the nature of the
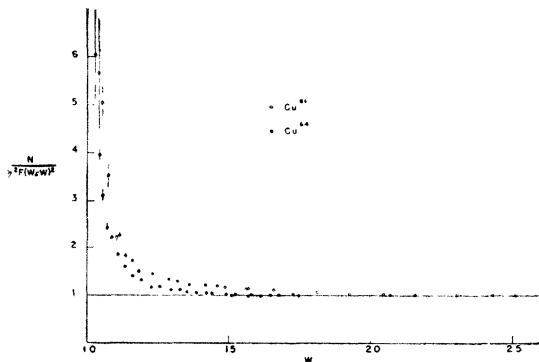

Fig. 2. The ratio of the observed number of positrons per unit momentum interval to that predicted by the Fermi theory for an allowed transition as a function of the total positron energy. The open circles are for Cu^{61}. The closed circles show the data for Cu^{64}.

deviation for the two isotopes cannot be explained in terms of Coulomb effects on the positrons. It would be of additional interest to compare the spectra of two allowed transitions having the same end points but different Z. Such a comparison is possible between Cu^{61} and N^{13}. It is perhaps significant that the data of Siegbahn and Slätis[5] for N^{13} begin to deviate from the theory at just about the same energy as our data for Cu^{61}. However, since their data were obtained with a source of "some mg/cm²," a more detailed comparison is not justified at low energies.

We wish to express our thanks to Mr. H. Clay Price, Jr. for assistance in obtaining the data.

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Erratum: On the Nuclear Moments of I^{127}, Ga^{69}, Ga^{71}, and P^{31}

R. V. POUND
Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts

IN the above letter, line 13 of column two on page 1112 should read

$$\nu(Ga^{71})/\nu(Na^{23}) = 1.1529 \pm 0.0004$$

instead of

$$\nu(Ga^{71})/\nu(Ga^{69}) = 1.1529 \pm 0.0004.$$

Errata and Addendum: On the Mechanism of Electron Emission at the Cathode Spot of an Arc

JEROME ROTHSTEIN
Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey

IN a recent Letter to the Editor under the above title, several errors appear, viz.: p for rho in the first two formulae, alpha for d in the first formula, $10^{-4}N$ for $10^4 N$ in the third formula, Mc for sec in the next to the last paragraph. As normal velocity components are considered, a factor $\frac{1}{3}$ should appear before the integral in the second formula. The error in the third formula, the only one of consequence, invalidates the temperature calculation. It seems better to replace transit time considerations by the following picture of processes taking place at the cathode surface.

In a Hg arc, some 10^{21} ions hit unit area of the cathode spot per unit time. Having energies of about 10 e.v. many of them may penetrate to depths of one or more atomic

diameters, sharing their energy with cathode atoms. The heat of vaporization is less than 1 e.v. per particle. Accordingly, in the spot microvolume, particle energies are so high that conditions resemble those of a highly compressed gas in the supercritical region more than those of the solid or liquid state. To this region electrons flow metallically, from it they are emitted thermionically. More than a superficial parallel appears to exist between steady state arc spot conditions and transient conditions encountered in experiments on wires exploded by tremendous peak currents.

This picture agrees with the experiments of Plesse[1] on the important role of metallic vapor at the cathode spot. He found, for example, that the essential characteristics of Zn, Cd, or Hg arcs could be obtained with a Ni cathode supplied with Zn, Cd, or Hg vapor, respectively, by evaporation from an oven or from the cathode of an auxiliary discharge. The vapor source could be inside or external to the cathode. Nitrogen was the gas employed.

[1] H. Plesse, Ann. der Physik **22**, 473 (1935).

Photoelastic Properties of Cubic Crystals

Elias Burstein and Paul L. Smith
Crystal Section, Naval Research Laboratory, Washington, D. C.
June 7, 1948

THE photoelastic effects in cubic crystals have been explained by Mueller[1] in terms of the anisotropy of the Lorentz-Lorenz and Coulomb forces produced by a distortion of the lattice. The contribution of the optical anisotropy of the ions was taken into account by means of phenomenological constants. This contribution was found to be negative for the few crystals for which data were available at the time, and Mueller assumed that it would also be negative for other crystals.

Additional photoelastic data have been obtained recently at this laboratory[2] which show that Mueller's conclusions concerning the optical anisotropy contribution must be modified. A summary of these and other recent data is given in Table I.

The purpose of this note is to present these results and to discuss further the significance of the optical anisotropy constant λ_0. Some qualitative relations between λ_0 and the temperature dependence of the refractive index will also be discussed.

In general, Mueller's predictions for crystals having NaCl structures are correct but his predictions of the sign of $(p_{11}-p_{12})$ for diamond and CsCl structures (thallium halides) are wrong. Assuming the correctness of the theory in evaluating the $L-L$ and Coulomb contributions, the error apparently lies in Mueller's assumption concerning the optical anisotropy contributions. For diamond which is monatomic and covalent this contribution (as measured by Mueller's optical anisotropy constants $(\lambda_{12}$

$-\lambda_{11}))$ can be unambiguously calculated using the theory and the experimental values of $(p_{11}-p_{12})$. This calculation yields $\lambda_{11}=+0.7$; $\lambda_{12}=+2.0$; $\lambda_{44}=+1.8$. The optical anisotropy contribution is positive $(\lambda_{12}-\lambda_{11}=+1.3)$ and larger than the $L-L$ contribution of -0.66. It is suggested that in the thallium halides the optical anisotropy contribution is also positive and large enough to more than compensate for the negative $L-L$ and Coulomb contributions. Such a positive contribution could result from the fact that in a CaCl structure the cation-anion bond is directed along [111], and a [100] strain alters the anion-anion distance more than the cation-anion distance. A similar effect would be expected for ZnS and diamond structures.[5]

Values for the change in refractive index with density $(\rho dn/d\rho)$ and the optical anisotropy constant for hydrostatic pressure λ_0 (corresponding to the change in molar polarizability with volume) are also given in Table I. In all cases the observed values of $\rho dn/d\rho$ were smaller than the calculated values, and in MgO and diamond the measured $\rho dn/d\rho$ is actually negative; that is, a hydrostatic pressure is found to cause a decrease in refractive index. As a result, the λ_0 values for these crystals are greater than one, indicating that the change in ionic polarizability is greater than the effect of changing the number of ions per unit volume.

Since the change in ionic polarizability with strain results from a change in the overlap of the ions, it is suggested that its magnitude depends on the amount of overlap present in the unstressed crystal and that λ_0 may be used as a measure of the amount of homopolar bonding. This is borne out by correlation with other methods of estimating homopolar bonding.

Data on the change of index with temperature are also of interest. From existing data on dn/dT it appears that for those simple crystals which contain no radicals and have small λ_0 values, the change of index with temperature is determined mainly by the density contribution $(\partial n/\partial \rho)_T$ $\times (d\rho/dT)$; the temperature contribution $(dn/dT)_\rho$ is small, and dn/dT is negative. For crystals with large λ_0 the temperature contribution is positive and about the same order of magnitude as the positive density contribution. From these considerations one would, therefore, predict MgO to have a positive dn/dT. For ZnS, which is known

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Table I.

Crystal	$p_{11}-p_{12}$	p_{44}	p_{11}	$\rho dn/d\rho$ obs	λ_0
LiF	−0.108 (−)**	−0.064 (−)**	~0.02	~0.1	~0.7
NaCl	−0.043 (−)	−0.010 (−)	0.11	0.24	0.60
KCl	+0.046 (+)	— (−)	0.17	0.23	0.60
KBr	+0.049 (+)	−0.26 (−)	0.22	0.35	0.50
KI	+0.041 (+)	— (−)	0.21	0.43	0.50
MgO	−0.24 (−)	— (−)	~−0.13	~−0.4	~1.4
TlCl*	+~0.03 (−)	+~0.06 (+)	—	—	—
Diamond³	+0.45 (−)	+0.011 (+)	0.125	−2.62	1.5
K-Alum⁴	−0.08	−0.0056	0.27	0.53	0.06

$$\lambda_0=1-\frac{\rho(dn/d\rho)\text{obs}}{\rho(dn/d\rho)\text{calc}}$$

$$\rho(dn/d\rho)\text{obs}=\frac{n^3}{6}(p_{11}+2p_{12})$$

$$\rho(dn/d\rho)\text{calc}=\frac{(n^2-1)(n^2+2)}{6n}$$

* Values for TlCl approximate.
** The signs of the photoelastic constants as predicted by Mueller are given in parenthesis.