with the incident beam and separated from the target by a 15-cm long channel formed by lead blocks was placed a counter telescope consisting of two thin-walled counters. Behind the telescope was an aluminum plate inclined at an angle of 45 degrees to the direction of the telescope. Beside this plate, out of line with the target and telescope, was placed a third thin-walled counter. The purpose of the arrangement was to detect charged mesotrons which were created in the target and stopped in the aluminum plate after traversing the telescope, the decay electrons tripping the third counter. The circuits were adjusted so that processes were recorded in which the third counter was set off 1.0 to 1.4 microseconds later than the two counters of the telescope. With a beam of 10^{-9} ampere at the target, real delayed coincidences occurred at a rate of two per minute.

However, the counting rate was not changed appreciably by removing the aluminum plate or by interposing several millimeters of lead between the telescope and the delay counter to shield the latter completely from the expected decay electrons. Therefore, the observed counts can not be attributed to charged mesotrons decaying into electrons.

If charged mesotrons of low mass are actually created when the deuterons strike the target, the failure of this experiment may be laid to a combination of three causes:

(1) Production cross section too small. If the lifetime of these particles is of the order of 10^{-6} second, a cross section for production greater than 10^{-31} cm^2 would be sufficient for their detection in this experiment.

(2) Lifetime too long or too short. If the cross section for production is 10^{-30} cm^2, as for the uncharged mesotrons, then particles of a lifetime longer than 10^{-5} second or shorter than 5×10^{-7} second would pass unnoticed.

(3) Kinetic energy acquired by the mesotron at the moment of creation too small for it to penetrate the target material and the counter walls. A charged particle of rest energy 20 mc^2 and a kinetic energy of 1 Mev or less would easily be stopped before reaching the aluminum plate.

[1] G. K. Groetzinger, P. G. Kruger, and L. Smith, Phys. Rev. **67**, 52 (1945).
[2] G. K. Groetzinger and L. Smith, Phys. Rev. **67**, 53 (1945).
[3] M. Schein (private communication).
[4] P. G. Kruger and L. W. Smith, abstract presented before the Stanford meeting of the American Physical Society, July 14, 1945.
[5] P. G. Kruger, G. K. Groetzinger, *et al.*, Rev. Sci. Inst. **15**, 333 (1944).

Refraction Effects in Electron Diffraction

LORENZO STURKEY AND LUDO K. FREVEL
The Dow Chemical Company, Midland, Michigan
July 3, 1945

IN an attempt to use MgO smoke as a calibration specimen for electron diffraction patterns in a camera with a 72.3-cm specimen-to-plate distance, rather unexpected diffraction patterns were obtained:

(a) The (*hhh*) reflections appeared as resolved doublets.
(b) The (*h*00) reflections were very sharp.
(c) Other reflections were considerably broadened.

(This phenomenon for MgO has also been observed by J. Hillier and reported without explanation in a contributed paper at the American Physical Society meeting at Ohio State, June, 1945. Hillier used a camera with a 20-cm specimen-to-plate distance.)

Since x-ray back reflection patterns taken with Cu$K\alpha$-radiation of MgO smoke deposited on a glass microscope slide showed no signs of deviation from the usual cubic structure, it must be concluded that the broadening and doubling of reflections other than (*h*00) are characteristic of electron diffraction. It is well known that electron diffraction patterns are very sensitive to the shape of the diffracting particles. The observed splitting of the non-pinacoid reflections is attributable to the uniform cubic habit of MgO smoke. Electron rays reflected from the (*h*00) planes pass through the crystal as through a parallel plate and suffer no appreciable change in direction other than the change by diffraction; but rays reflected from prism planes often pass through an effective prism and suffer an additional change in direction due to refraction at the crystal faces. To check this deduction, the following observations were made:

(1) CdO smoke, which also shows a pronounced cubic habit, gives electron diffraction patterns exhibiting the same peculiarities as MgO smoke.

(2) MgO was prepared in irregularly shaped particles ranging in size from 200A to 500A as observed in the electron microscope. Electron diffraction patterns of this material showed no anomalies, and all diffraction rings are essentially equally sharp, though not so sharp as for MgO smoke.

(3) Diffraction patterns of MgO smoke were taken at various electron accelerating voltages. It was frequently observed that, at lower voltages, the center of the broadened (220) reflection decreased in intensity. Since this central part is due to diffraction through a consistently thicker portion of the crystal than the side parts, absorption tends to decrease the intensity at lower voltages.

(4) ZnO smoke patterns show broadening of the (100) and (101) reflections. This material has a spike-like habit instead of cubic.

For a cube-shaped crystal, the deviation of the electron rays in the diffracted direction—the only direction affecting ring broadening—may be approximately calculated by finding an "effective refracting triangle" for the ray. This effective triangle is found by passing a plane through the cube perpendicular to the diffracting plane and including the incident and reflected rays from this diffracting plane. The intersection of this plane with the diffracting plane is the base of the effective triangle, and the intersections with the faces of the cube on the "reflecting" side of the diffracting plane form the other two sides. The deviation δ in radians from the Bragg angle is given approximately by the following expression:

$$\delta=(\pm[\tan^2 r_1+\sin r_1\cos r_1]\pm[\tan^2 r_2+\sin r_2\cos r_2](P/2E),$$

where

r_1 and r_2 are the angles of refraction at sides of triangle, sign of brackets being *negative* if face normal is between ray and diffracting plane, and *positive* otherwise

P = inner potential of crystal
E = accelerating potential of electrons.

A calculation of the inner potential of MgO from the doublet spacing of the (111) reflection gives a value of 12 ± 4 volts, which agrees in order of magnitude with measurements, etc., of inner potentials for other ionic crystals.[1]

A more detailed analysis of the effect of refraction on electron diffraction patterns will be published later.

[1] (See Thomson and Cochrane, *Theory and Practice of Electron Diffraction*, Chap. X.)

K-Capture and e^+-Emission of 6.7-hr. Cd: An Experimental Verification of the Fermi Theory of β-Decay

H. Bradt, P. C. Gugelot, O. Huber, H. Medicus, P. Preiswerk, and P. Scherrer
Physikalisches Institut der Eidgenössischen Technischen Hochschule, Zurich
July 3, 1945

IT may be possible to discriminate between different theories of β-decay by the determination of the relative probabilities of K-capture and e^+-emission. The experimental difficulties of an exact determination of this kind are evident; until now, no exact value of the quotient $Q=p_K/p_+$ for an allowed transition was known.

We found, that the 6.7-hr. $Cd^{107/109}$ which is mostly decaying by K-capture, emits also positive electrons. The e^+-spectrum was measured with the magnetic spectrometer and the upper limit of the spectrum found to be $E=(320\pm10)$ kev. The corresponding annihilation-radiation was detected by $(\gamma\text{-}\gamma)$-coincidences, following the 6.7-hr. period.

Both disintegrations, K-capture and e^+-emission, lead to a metastable $Ag^{107/109}$-nucleus which goes over to the stable Ag with a half-period of (44.3 ± 0.2) sec. Only 1 percent of this transition is connected with the emission of a 93.5-kev γ-ray; in 99 percent, according to the high internal conversion coefficient, a K, L, or M electron is ejected. Therefore, the number of conversion-electrons of the 93-kev radiation, emitted by the 44-sec. $Ag^{107/109}$ in equilibrium with the 6.7-hr. Cd, is practically equal to the total number of the Cd-disintegration-processes. The relative probabilities of K-capture and e^+-emission are therefore in this special case easily determined, being the proportion of the total number of conversion-electrons to the total number of positrons from the same source of 6.7-hr. Cd.

The experimental value, determined with the magnetic spectrometer is found to be

$$Q_{\text{exp}}=p_K/p_+=320\pm20$$

in excellent agreement with the theoretical value calculated according to the Fermi theory of β-decay.

$$Q_{\text{theor Fermi}}=342.$$

The Konopinski-Uhlenbeck modification leads to a value 60 times greater than the one actually found:

$$Q_{\text{KU}}=19800.$$

With $\lambda_+=8.97\times10^{-8}$ sec.$^{-1}$ and $W_+/mc^2=1.62$ the matrix element of the Fermi theory turns out to be $M=0.125$, the e^+-decay therefore corresponding to an allowed transition.

Besides the radiation of 0.51 Mev resulting from annihilation of the e^+, we were able to measure the energy and intensity of the weak nuclear γ-radiation of the 6.7-hr. Cd. The energy of this γ-radiation is 0.842 Mev and the absolute intensity is 0.042 quanta per disintegration. The K-capture leading to the excited level of Ag with 0.842 Mev energy is, therefore, at once forbidden. A detailed report will be published in the *Helvetica Physica Acta*.