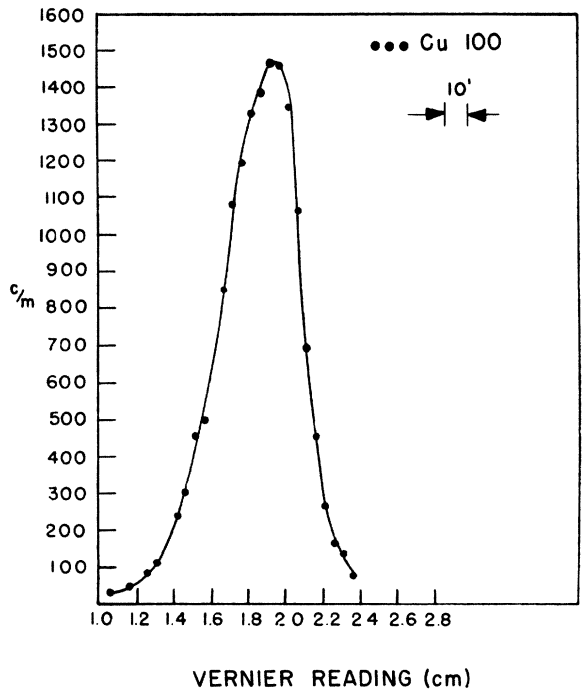

FIG. 2. Contour of Bragg peak from a diffracting plane parallel to growth direction, showing decrease in lineage.

well known to metallurgists, but has not as yet been specifically correlated with the diffraction of neutrons. The lineage structure is a result of the growth process and appears as a fibrous structure in the direction of growth. Figure 1 is a diffraction pattern of a crystal from a diffracting plane approximately perpendicular to the growth direction, with the beam intercepting many lineage regions. Figure 2 is a diffraction pattern from a diffracting plane parallel to the growth direction. In the latter case the beam was parallel to the fibers and intercepted only 2 lineage regions.

These results are important in connection with neutron crystal monochromators, since neutron beams are large enough and penetrate deeply enough to be affected by lineage. In a previous search for good monochromating crystals, double-crystal rocking curves were taken[3] at Oak Ridge, and an attempt was made to interpret the results with the dynamical theory of x-ray diffraction assuming the angular distribution of coherent domains to be gaussian. In most cases the reflectivities were too small by a factor of 2, and it now appears that the discrepancy may be due to lineage (two of the crystals were checked with the present apparatus and were found to contain pronounced lineage). The lineage structure is lost to a great extent in double-crystal rocking curves.

The wavelength resolution, $\Delta\lambda/\lambda$, of a crystal monochromator is related to the angular spread of the coherent domains, $\Delta\theta$, by

$$\Delta\lambda/\lambda=\Delta\theta/\tan\theta_B,$$

where θ_B is the Bragg angle. Twenty assorted crystals grown from the melt (Be, Mg, Cu, Ni, Pb, Bi, NaCl, LiF) were examined, and all contained pronounced lineage with an average $\Delta\theta$ of about 30 minutes. Thermal annealing of lead in general reduced this, and in one case $\Delta\theta$ was reduced to 2.5 minutes. On the other hand, $\Delta\theta$ may be increased by about an order of magnitude by straining crystals below their temperature of recrystallization. In crystals used for monochromators, $\Delta\theta$ should be approximately the same as the geometrical resolution of the instrument. Because of its ease of growth, its high coherent cross section and low absorption, and the ability to vary the lineage to some extent, it appears that lead makes a suitable monochromator for neutrons.

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† Permanent duty station, Brookhaven National Laboratory.
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Radioactivity of F^{17}

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THE gamma-radiation from F^{17} has been re-examined with a scintillation counter and a pulse-height analyzer.

Distilled water was bombarded with deuterons in the internal beam of the 36-in. cyclotron and half-lives were measured at different pulse-height settings. With the increased activity which was produced in this way, and the better energy discrimination, it was found that the previously reported gamma-rays[1] of energy higher than that of annihilation radiation had a half-life distinctly shorter than that of F^{17}.

The large chemical activity of fluorine and of the ozone which is produced when gaseous oxygen is bombarded makes it likely that some impurity was carried along in the previous experiments.

We conclude that F^{17}, in common with other mirror image nuclei which have been investigated with spectrometers, does not emit any nuclear gamma-radiation.

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Measurement of Some Internal Conversion Coefficients*

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THE lifetime-energy relations of Axel and Dancoff[1] lead to the interpretation that the isomeric transitions in Cd^{111m} (48.6 min, 149 kev), Cs^{134} (3.15 hr, 128 kev), and Ta^{182m} (16.4 min, 180 kev) are of multipole order $\Lambda=4$; i.e., electric 2^4-pole ($E4$) and/or magnetic 2^3-pole ($M3$). Measured K/L ratios for these transitions,[2] when compared with the approximately calculated ones of Hebb and Nelson,[3] support the interpretation that these transitions are of the $E4$ type ($\Delta I=4$, no parity change). In addition, the conversion coefficient for Cd^{111m} has been recently reported[4] to agree with that theoretically expected[5] for an $E4$ transition. This is in direct contradiction to the predictions of the strong spin-orbit coupling shell model for Cd^{111m}. The second step (247 kev) of this two-step isomeric transition is an $E2$ transition on the basis of its conversion coefficient.[4] The ground-state spin and magnetic moment of Cd^{111} indicate that it may be designated as an $s_{1/2}$ state. In terms of the shell model the decay of Cd^{111m} would thus be most naturally designated by the transitions

$$h_{11/2} \xrightarrow{149\text{ kev}} d_{5/2} \xrightarrow{247\text{ kev}} s_{1/2}$$

as pointed out by Johansson.[6] The 149-kev transition would be of the $E3$ type ($\Delta I=3$, change in parity). In terms of the classification of Axel and Dancoff,[1] the observed lifetime of the 149-kev transition would then be $\approx 10^7$ times slower than the calculated lifetime.

Weisskopf has recently derived new lifetime-energy relations[7] which give considerably smaller radiation probabilities for all electric transitions with $\Delta I\geq 2$. (The factor is, however, too small to account for the observed discrepancy.) The reclassification of

isomers by Goldhaber and Sunyar[8] has shown that the group of isomers previously identified with $A=4$ ($E4$ and $M3$ transitions) consist really of transitions with $\Delta I=3$ ($E3$ and $M3$ transitions), and that the calculated K/L ratios of Hebb and Nelson[3] for electric transitions with $\Delta I \geq 3$ yield spin changes one unit too high. In the new classification, Cd^{111m}, Cs^{134m}, and Ta^{182m} are $E3$ transitions. These transitions are the slowest of the $E3$ group and in fact are nearly slow enough to be compatible with Weisskopf's $E4$ lifetime formula. The K/L ratios for these transitions clearly

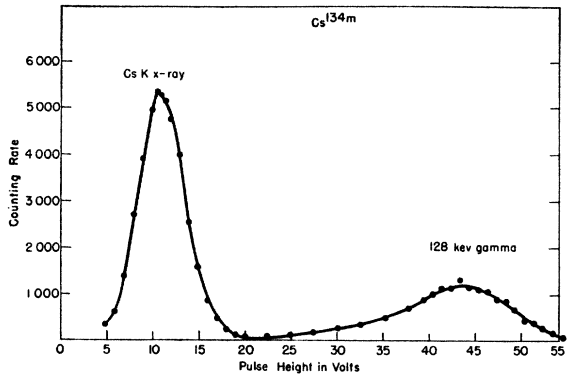

FIG. 1. Pulse-height distribution from Cs^{134m}.

indicate their electric character. An accurate measurement of the internal conversion coefficients will thus decide in favor of $E3$ or $E4$.

Measurements of the conversion coefficients have been made with a scintillation counter using a 1-cm cube crystal of NaI (Tl). A single-channel differential discriminator was used for determining the pulse height distribution. The K conversion coefficient was determined by comparing the intensity of the K x-rays relative to that of the unconverted gamma-ray. The heights of the

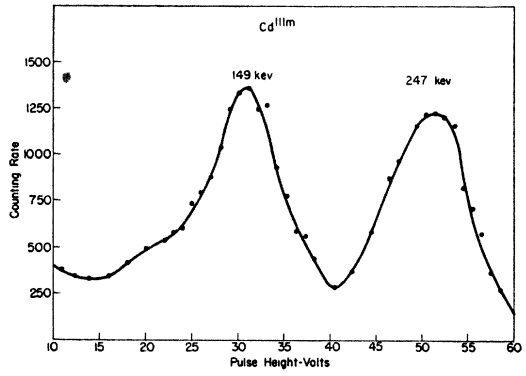

FIG. 2. Pulse-height distribution from Cd^{111m}, showing the unconverted 149-kev and 247-kev gamma-rays.

photopeaks above background give directly the K conversion coefficient when corrections are applied for the following factors: (1) the percent absorption of the radiations in NaI 1-cm thick;[9] (2) the ratio of photoelectric cross section to total absorption cross section,[10] including the effect of Compton scattering by Na in the crystal; (3) the fluorescent yield for the x-rays;[11] (4) the variation of half-width for a photopeak with γ-energy; (5) the change in the fractional acceptance interval, $\Delta E/E$, of the channel with discriminator setting; (6) variation, if any, of the absolute channel width ΔE with discriminator setting. The method has been checked by a measurement of the x/γ-ratio for Te^{123m}. The computed value expected from previous measurements of electron intensities[12] is 0.61, while the measured value is 0.59 ± 0.08.

The sources were prepared by slow neutron bombardment in the Brookhaven reactor. In the case of cadmium, the separated isotope Cd^{110} obtained from Oak Ridge was used.

A typical pulse height distribution from which x/γ-ratios are obtained is shown in Fig. 1 for Cs^{134m}. In Fig. 2 are shown the photopeaks of the 149- and 247-kev gamma-rays of Cd^{111m}, from which the $\gamma 149/\gamma 247$ ratio may be computed. The conversion coefficient for the 247-kev gamma-ray is known,[4] and hence the total conversion coefficient for the 149-kev gamma-ray is determined. The known K/L ratio for this transition[4] allows α_K to be determined. The experimental results are summarized in Table I.

TABLE I. Experimental and theoretical conversion coefficients.

Isomer	E(kev)	Measured α_K	Theoretical α_K[a] $E3$	$E4$
Cd^{111m}	149	x/γ: 1.45 ± 0.4 $>1.5\pm0.3$ $\gamma 149/\gamma 247$: 1.60 ± 0.5	1.4	7.1
Cs^{134m}	128	2.2 ± 0.4	~2.45	~12
Ta^{182m}	180	0.8 ± 0.3	0.69	2.05

[a] See reference 5.

The measurements are compatible only with the conclusion that all of the transitions are of the $E3$ type in spite of their comparatively long lifetime.

* Research carried out under contract with the AEC.
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Disintegration of Sn^{119m}

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EARLIER experiments[1] on the disintegration of Sn^{119m} showed the existence of a strongly converted 69-kev transition, of 250-day half-life, and probably $M4$ character. It was suggested that this transition should be followed by a second transition, probably of $M1$ character.

The first sources proved to be too weak to measure an accurate energy of the first transition or to observe the existence of the

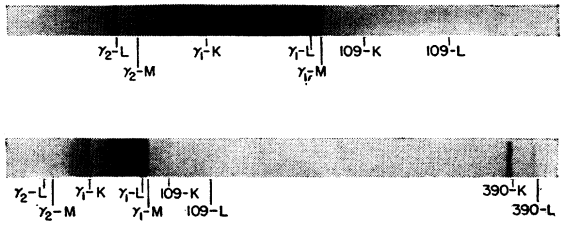

FIG. 1. Conversion spectra of Sn^{119m}. Upper spectrum, 100-gauss magnet. Lower spectrum, 200-gauss magnet. $\gamma_1=65.3$ kev, $\gamma_2=24.2$ kev; 109-kev transition from Te^{125m}, 390-kev transition from In^{113m} (produced from Sn^{124} and Sn^{112} by neutron capture and subsequent decay).