$E=0.476$ mc^2 there is no longer a singly scattered beam; the solution has the appearance of a wave running across as the energy decreases. Not all the departure from isotropy at these lower energies is due to the beam which is scattered twice—there is still a slight "wave" in existence when the second scattered beam is eliminated. This is largely due to photons which are scattered every time except once through angles close to 0° or to 180° and thus have some remembrance of their original direction.

The solution in the case of lead has the same general features, except that the low orders of scattering are much more important, due to the increased competition which pair production and photoelectric effect give to Compton scattering. Also, instead of a build-up in the total density of photons at lower energies, there is a sharp decrease, due to photoelectric effect.

A more detailed account of this work will appear in the Journal of Research of the National Bureau of Standards.

We should like to thank Dr. U. Fano for suggesting this problem and for many valuable discussions during the course of the work.

* Work supported by an ONR grant.

[1] See e.g. M. Verde and G. C. Wick, Phys. Rev. **71**, 852 (1947).
[2] P. R. Karr and J. C. Lamkin, Phys. Rev. **76**, 1843 (1949). This is paper III of the series; papers I and II are quoted there.

Radioactive Lanthanum 140

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November 4, 1949

The single natural isotope of lanthanum of mass 139 should, on neutron capture in the pile, yield the radioactive isotope of mass 140. This emitter has been previously studied by many investigators.[1] Because of the difficulty of chemical purification, impurities are likely to be present. A highly purified sample separated by Dr. G. E. Boyd was kindly made available and irradiated in the Oak Ridge pile.

This specimen shows a remarkably pure decay through eight octaves with a half-life of 41.4 hours. In photographic beta-spectrometers, many electron conversion lines are observed, about 16 in all, with energies less than 500 kev. These are shown in Table I, together with their proposed interpretation and the values of the resultant probable 12 gamma-rays. The $K-L$ differences where observed are characteristic of cerium, indicating that gamma-emission follows the loss of a beta-particle from the lanthanum nucleus.

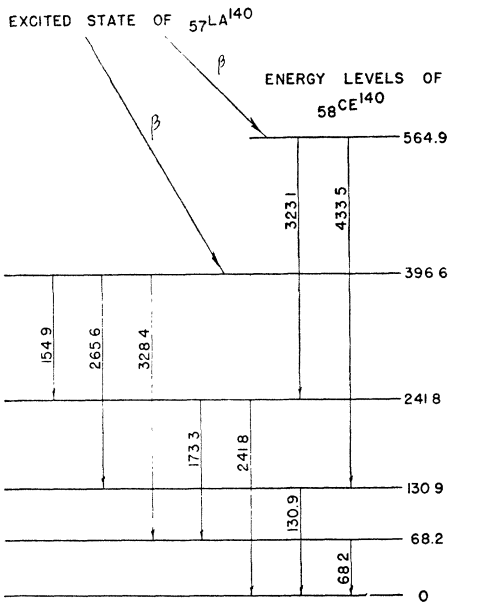

Fig. 1. A possible level scheme associated with $_{57}La^{140}$.

The observed gamma-rays may be fitted into a level scheme as shown in Fig. 1. The sums of all possible combinations agree as expected to within about 0.2 kev. The gamma-rays observed at 109.1 and 487.1 kev do not, however, fit into the level diagram. The only positions they could occupy and remain consistent with the scheme would be either above or below the group of levels shown in Fig. 1. The electron line at 483.2 kev may also be interpreted as a K line, in which case the gamma-energy is 523.5 kev. This value happens to be almost exactly the sum of three observed gamma-rays of 109.1, 173.3, and 241.8 kev. The presence of these two anomalies indicates that some ultimate revision of the proposed level scheme may be necessary, to include also the higher energy gamma-rays.

Table I. Conversion electron and probable gamma-ray energies.

Electron energy	Probable identification	Energy total	Gamma-energy
27.9 kev	K_1	68.2 kev	68.2 kev
68.7	K_2	109.0	109.1
90.7	K_3	131.0	130.9
103.0	L_2	109.2	
107.9	M_2	109.3	
114.6	K_4	154.9	154.9
124.5	L_3	130.7	
133.0	K_5	173.3	173.3
201.5	K_6	241.8	241.8
225.3	K_7	265.6	265.6
282.8	K_8	323.1	323.1
288.2	K_9	328.5	328.4
322.0	L_9	328.2	
393.2	K_{10}	433.5	433.5
446.8	K_{11}	487.1	487.1
483.2	K_{12} or L_{11}	523.5 489.4	523.5

The beta-emission had been previously shown to be complex. Higher energy gamma-radiation is present which by absorption in lead had an energy of 1.88 Mev. The long-lived 140-day activity previously reported does not appear to be present in this specimen.

This investigation was made possible by the joint support of the ONR and the AEC.

[1] Weimar, Pool, and Kurbatov, Phys. Rev. **63**, 67 (1943); R. Osborne and M. Peacock, Phys. Rev. **69**, 679 (1946); C. Mandeville and M. Scherb, Phys. Rev. **73**, 1434 (1948); Mitchell, Langer, and Brown, Phys. Rev. **71**, 140 (1947); Cork, Shreffler, and Fowler, Phys. Rev. **74**, 240 (1948).

Ferroelectricity in the Ilmenite Structure

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November 7, 1949

Single crystals of $LiTaO_3$ and $LiCbO_3$ have been found to be strongly ferroelectric as is indicated by the existence of a saturation polarization in their dielectric hysteresis loop. The saturation value increases rapidly with temperature as shown in Fig. 1. $LiCbO_3$ exhibits a similar behavior at higher temperatures.

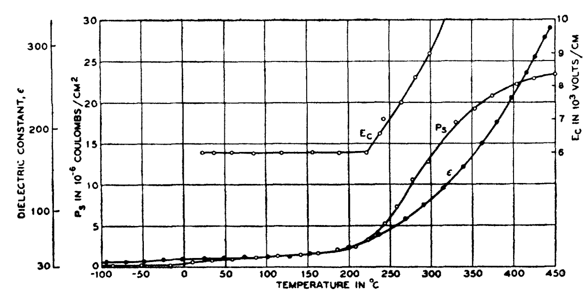

Fig. 1. Saturation values in a single crystal of $LiTaO_3$ as a function of temperature.

$LiCbO_3$, with which $LiTaO_3$ is isomorphous, was described by Zachariasen[1] as belonging to the ilmenite structure, which is centro-symmetric. The existence of a spontaneous polarization, however, indicates the absence of a center of symmetry. A further