mann's data. In the gamma-ray measurements the pulse-height distribution and the discrimination level were such that the integral of the pulse-height distribution was an acceptable index of the relative light output, as verified by Liebson.[5] The filter arrangement of Fig. 1 was not used.

The relative increases in light output (at the various solute concentrations) due to oxygen removal are the same for light excitation as for gamma-ray excitation within the accuracy of the measurements. On the basis, we attribute the oxygen-quenching effect to occur in the *solute*.

The data of Fig. 3 permits us to infer something in addition concerning the mechanism of the solvent-to-solute energy transfer. If the energy transfer were by means of solvent photon emission and subsequent solute absorption as proposed by Birks,[6] the concentrations at peak light output should be the same, independent of the method of excitation. The widely different peak-concentrations observed tend to support the collision-transfer mechanism suggested by Kallmann. The evidence is not entirely conclusive, however, since the spectrum of the exciting light used in these experiments was not identical to the emission spectrum of xylene.

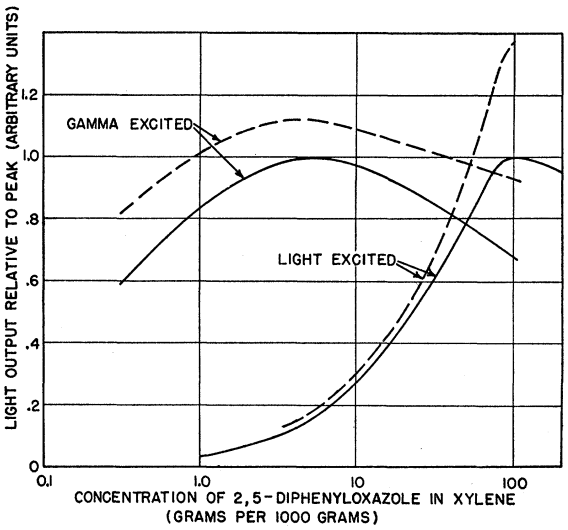

FIG. 3. Light output *versus* concentration curves for air-saturated and air-free 2,5 diphenyloxazole in xylene under gamma ray and under light-excitation. The solid lines are for air-saturated solutions and the dashed lines are for air-free solutions.

[5] S. H. Liebson, Nucleonics **10**, 7, 41 (1952).
[6] J. B. Birks, *Scintillation Counters* (McGraw-Hill Book Company, Inc., New York, 1953).

PHYSICAL REVIEW VOLUME 101, NUMBER 3 FEBRUARY 1, 1956

Evidence for the 258-kev Gamma Ray of Sn^{113}†

GERALD GARDNER AND JOHN I. HOPKINS
Vanderbilt University, Nashville, Tennessee
(Received September 19, 1955)

Measurements have shown that there appears to be a 258-kev gamma ray of Sn^{113} and that its intensity relative to that of the 393-kev gamma ray is 12%±2%. The half-life for each gamma ray was measured to be approximately 130 days.

EVIDENCE has been obtained by means of the NaI(Tl) scintillation spectrometer for the presence of a 258-kev gamma-ray transition in the decay of Sn^{113}. A 255-kev gamma ray, together with gamma rays of energies 400.9 kev and 393.3 kev has been reported as belonging to Sn^{113} by Cork *et al.*,[1] who proposed a decay scheme consisting of orbital electron capture followed by emission of all gamma rays in cascade. Thomas *et al.*[2] proposed a decay scheme consisting of electron capture followed by the emission of a single gamma ray of energy 390 kev, having failed to confirm the presence of any other gamma rays. The work of both Cork and Thomas was carried out with beta-ray spectrometers.

Recent work by Deschamps and Avignon[3] using a spectrometer of rather low resolving power failed to confirm the presence of any gamma ray except that of energy 393 kev.

Figure 1 is typical of the Sn^{113} spectra obtained. The theoretical Compton electron distribution should have electrons with a maximum energy of 238 kev. However, the finite resolution of the spectrometer results in a shift of the high-energy shoulder to an energy lower than 238 kev, to around 235 kev. The presence of a low-intensity peak at energy of 258 kev (Fig. 1) does not seem attributable to the Compton electron distribution.

In order to evaluate the intensity of this peak, a Compton electron distribution was subtracted from the

† Supported by an Atomic Energy Commission Research Contract.
[1] Cork, Stoddard, Branyan, Childs, Martin, and LeBlanc, Phys. Rev. 84, 596 (1951).
[2] Thomas, Haynes, Broyles, and Thomas, Phys. Rev. **82**, 961 (1951).
[3] Y. Deschamps and P. Avignon, Compt. rend. **236**, 478 (1953).

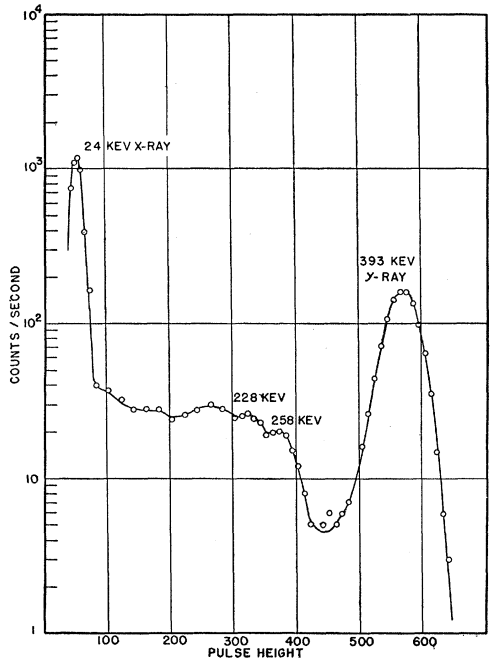

FIG. 1. Sn^{113} spectrum.

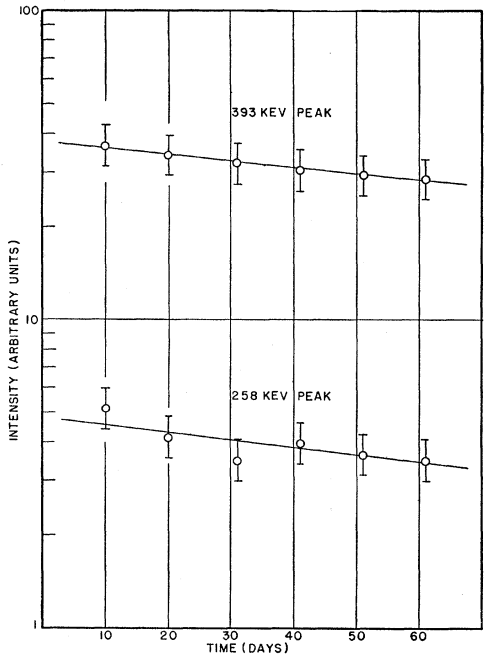

FIG. 3. Gamma-decay curves.

observed spectrum. This was accomplished by fitting a Gaussian curve to the high-energy side of a theoretical distribution in order to accommodate the finite resolution of the spectrometer. This distribution was then normalized to the observed spectrum, and subsequently

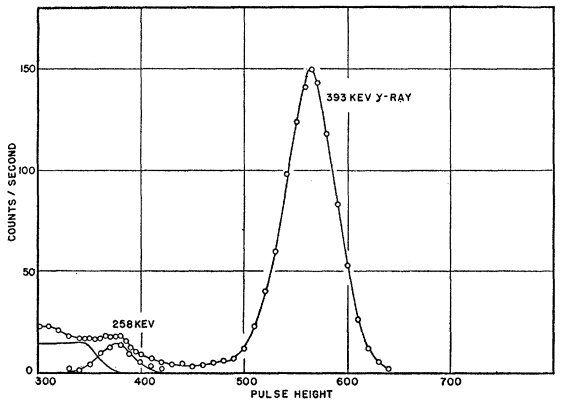

FIG. 2. Breakdown of Sn^{113} gamma spectra.

subtracted from it. The residual area under the 258-kev peak gives its intensity.

Characteristic low-energy tailing on the 393-kev peak, apparent in Fig. 1, results in distortion of the nearby lower-energy peaks. This tailing, not accurately determinable, was estimated and subtracted from the spectrum. The resultant analysis is shown in Fig. 2, with a Gaussian curve fitted to the residual 258-kev peak.

The intensity of this peak was determined at intervals of ten days over a period of fifty days. Intensity measurements were also made on the 393-kev peak. The resulting decay curves shown in Fig. 3 yield a half-life of 130 days for each gamma ray with an estimated error of plus or minus 3 days.

The determination of the intensity of the 258-kev peak is, of course, open to criticism on the grounds that low-energy tailing makes its true intensity rather uncertain. However, the limits of error estimated in the analysis seem sufficiently generous to validate the decay curve obtained. Its intensity relative to that of the 393-kev gamma ray is estimated to be $12\%\pm2\%$.

That the 258-kev peak belongs to Sn^{113} is supported by the agreement between half-lives and by the purity of the sample which was enriched to 72.5%.[4]

From the relative intensities of the 393-kev peak and the 258-kev peak, it does not appear possible that the two are in cascade. If the 258-kev transition represents an alternative mode of decay from the first excited level to an intermediate level, or from an intermediate level to the ground level, then another gamma ray of energy 135 kev should be present. Such a peak was not found; however, this energy is quite near that of the characteristic back-scatter peak and could well be present but obscured.

[4] Obtained from the Stable Isotope Division of the Oak Ridge National Laboratory.