higher l, λ_l decreases rapidly. It might be thought[4] that G_l should decrease with l, since in the same potential well, the increase of centrifugal force would decrease the average kinetic energy and so reduce the frequency of collision with the barrier. However, it must be remembered that the depth of potential well has little physical significance, and preserving the same depth for different l's would be meaningless. The physically important fact is that the barrier is relatively high and the leak through it is small and therefore the wave function must nearly vanish at $r=r_0$; this implies $mv_i^{(l)}r_0/\hbar\sim$first root of $J_{l+\frac{1}{2}}$, where $v_i^{(l)}$ is approximately the maximum velocity in the nucleus. Since the first roots of the bessel functions increase with l, we see that the necessity of "almost" imprisoning the α-particle in the nucleus can lead to a higher frequency of collision with the barrier and hence make G_l an increasing function of l.

Using the formula (2) for a square well, the results shown in Table I have been obtained. The ground-state radii were re-

TABLE I. Deviation of radii of excited states from ground-state radii.

Parent nucleus	Alpha-energy	Group abundance	l	Deviation (percent) Present	PY
Th^{230}	4.76	0.80	0		
	4.69	0.20	0	−0.7	−0.5
			1	−2.0	
Th^{228}	5.517	0.72	0		
	5.431	0.28	0	+0.5	+0.7
			1	−0.8	
Ra^{226}	4.877	0.931	0		
	4.695	0.069	0	+0.6	
			1	−0.6	

calculated and substantial agreement with the results of Kaplan was obtained. The deviation of the radius for each excited state from that for the ground state is listed as a percentage of the ground-state radius for $l=0, 1$. The corresponding figure from reference 1 is listed in the last column. For $l=1$ or 2, the radius will be smallest and will then increase rapidly for higher l's. Thus, although our figures are somewhat different from those of Perlman and Ypsilantis, it seems likely that there will be no large discrepancies for l up to about 3. There does not appear to be any reliable information on the multipolarity of the transitions in question.

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High Energy Bremsstrahlung and Pair Production*

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THE energy spectrum of photons from the Cornell synchrotron has been observed under various conditions with a magnetic pair spectrometer.[1] The photon beam was collimated by a slit, $\frac{3}{8}$ inch high by 1 inch wide, located 12 feet from the synchrotron target. The photons traversed a negligible amount of material before entering the spectrometer. The true coincidence counting rates from the spectrometer were corrected for the known variation of the pair cross section with energy[1] and for a geometrical efficiency which arises from the inability to detect all of the electron pairs from the $\frac{1}{2}$-mil gold radiator. The spectrum from a thin synchrotron target in the form of a $\frac{1}{2}$-mil tungsten ribbon is shown in Fig. 1. From such a target one would expect to get a bremsstrahlung spectrum integrated over all angles of the scattered electrons,[2] and this is borne out by the good fit to the curve which is the spectrum predicted by the Bethe-Heitler theory,[3] modified to account for the resolution of the spectrometer.

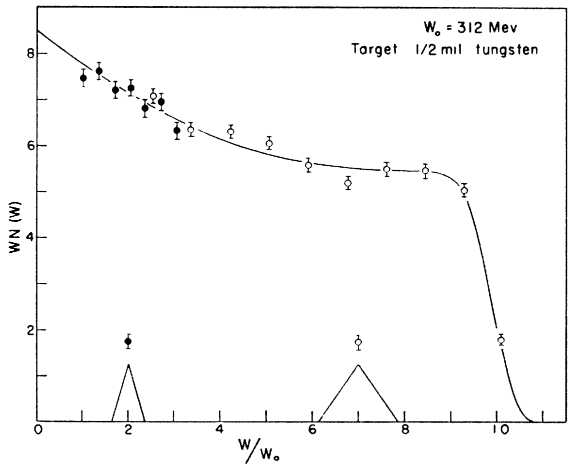

FIG. 1. Thin target photon spectrum from the synchrotron. The relative numbers of photons are multiplied by the corresponding energies. The resolution functions for the two sets of data are indicated by the triangles. The curve is computed from the Bethe-Heitler formula.

The maximum energy of 312 Mev is based on an absolute calibration of the spectrometer, which is estimated to have a limit of error of 2 percent.

The spectrum from our "standard" target, a 40-mil tungsten wire, has also been observed. The data indicate relatively fewer high energy photons than are present in the thin target spectrum. The ratio of 250-Mev photons to 50-Mev photons is five to ten percent lower than the corresponding ratio for the thin target data. This effect is in qualitative agreement with the cloud-chamber measurements of Powell, Hartsough, and Hill[4] and their calculated thick target spectrum, but a quantitative comparison with their calculations is made difficult by the uncertainty in our effective target thickness. For a given electron beam the thick target gave a total photon beam intensity only six times the thin target intensity, as measured with an ionization chamber behind one cm of lead. However, there is evidence of multiple electron traversals through the thin target;[5] thus no conclusion on the effective thickness of the wire can be drawn from this.

The shape of the spectrum at the high energy cutoff has been investigated more closely by taking data at slightly different settings of the spectrometer field in order to get more points on the steep portion of the curve. The data for both the thick and

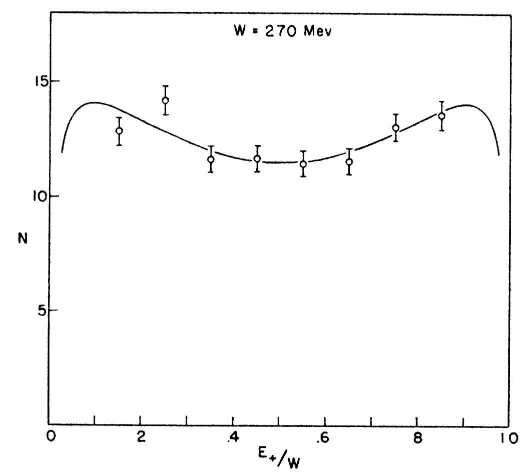

FIG. 2. The frequency of electron pairs from 270-Mev photons, plotted against the fraction of the energy carried by the positron. The experimental points are plotted, together with the curve expected from the Bethe-Heitler theory of pair production.

thin targets fit the calculated curve to within the statistical errors, which are similar to those in Fig. 1. However, the shape of the cutoff is measurably altered by spreading the beam in time. With a beam pulse 2.5 milliseconds long, the measured energy spread is about 2 percent, in agreement with the spread predicted from the time variation of the 30-cycle magnetic field.

Some experimental data on the energy sharing between members of electron pairs have also been obtained. Preliminary results were affected by scattering by the walls of the spectrometer vacuum chamber,[6] but after this effect was eliminated, the results shown in Fig. 2 were obtained for 270-Mev photons and a ½-mil gold pair former. The experimental points represent relative true coincidence rates for various pairs of counter groups representing the same total momentum of the electron pairs. The errors are the standard statistical errors. The curve is the Bethe-Heitler differential cross section;[3] the agreement is well within the statistics.

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Gamma-Radiation from I^{132}

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THE decay of the photoneutron activity created by neutron-irradiated U^{235} as measured by Bernstein and Talbot[1] has recently been analyzed by Ergen[2] and yielded tentative evidence for the existence of a gamma-ray above the photoneutron threshold of Be in the spectrum of I^{132}. This gamma-ray has been confirmed by Parker[2] using photoneutron methods and separated I^{132}. Since earlier absorption measurements[3] indicated no gamma-ray energies above 1.4 Mev, the present investigation was carried out to find this gamma-ray energy. Further interest may be evidenced in the I^{132} spectrum, since the Brookhaven National Laboratory has recently announced[4] the production of this isotope for medical purposes.

Numerous sources of I^{132} were distilled from separated Te in a 4 *M* HNO_3 solution with the addition of 7 percent H_2O_2. The iodine was collected as NaI in a dilute NaOH solution. The source, in all cases, was allowed to stand a sufficient time so that iodine activities from short-lived tellurium isotopes were not present. The measured half-life was 2.4 hr. For the preparation of the many sources used, the authors are indebted to Dr. George W. Parker of Oak Ridge National Laboratory.

Energy measurements were made by three methods, all using NaI crystals. In the first method, a single NaI crystal was used to obtain the spectrum shown in Fig. 1, curve A. This spectrum was run several times and was observed to decay with a half-life of 2.3 to 2.4 hr. Energies of the three gamma-rays listed in Table I were determined, using Cs^{137}, Co^{60}, and ThC″ gamma-rays as standards. The intensities in Table I were estimated by correcting the heights of the photoelectric peaks above background by the photoelectric cross section of NaI. A similar estimate with a Na^{24} source indicated equal intensities of the two gamma-rays within 14 percent.

TABLE I. Gamma-rays in I^{132}.

	Gamma-ray energy From single-crystal spectrometer	From Hofstadter-type two-crystal spectrometer	Relative intensity from single-crystal spectrometer
1	0.67	0.69 (0.80)	37
2	1.41	1.41	4
3	1.99	2.02	1

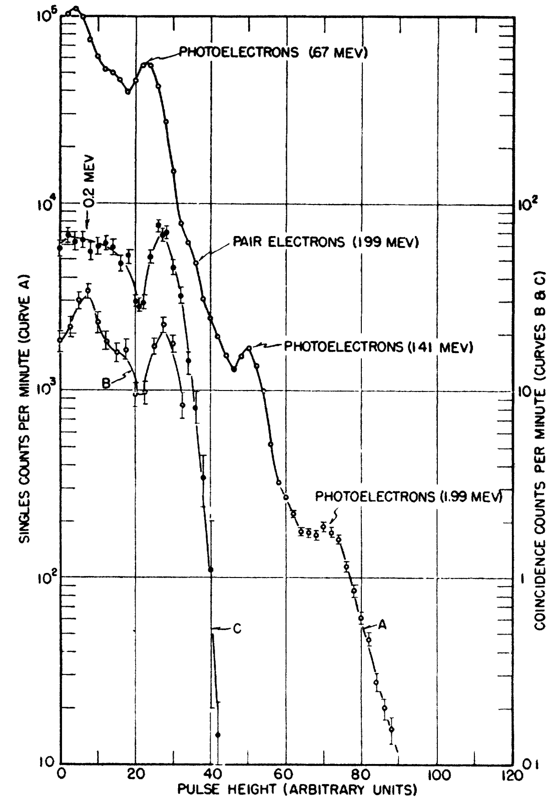

FIG. 1. Single-crystal and coincidence spectra of I^{132}.

Further measurements were made using two complete single-crystal spectrometers connected in coincidence, the source being placed midway between the two 1½-in. crystals which were about ¾-in. apart. For curve B, Fig. 1, one channel was fixed at the photoelectron peak of the 1.4-Mev gamma-ray with a window width of 15 units. The other channel, with a 2-unit window width, was varied to give the spectrum shown. A broad low energy peak was found at about 0.2 Mev. It seemed probable that this peak was due to backscattered secondary Compton gamma-rays. In order to reduce this effect, a ½-in. lead shield was placed between the crystals with a hole drilled in it so the source could see both crystals. Measurements made with a stronger source with this arrangement are shown in curve C, and the low energy peak had now disappeared. This curve was corrected by subtracting the chance coincidence rate as determined with a Cs^{137} source. The background rate amounted to about 25 percent of the total counting rate at the higher energy peak.

Since a peak occurs in the coincidence curves at 0.7 Mev (note that the gain had shifted slightly since the single run which was made two weeks earlier), the 0.7-Mev gamma-ray is in coincidence with either the 1.4- or the 2.0-Mev gamma-ray. The latter possibility was eliminated by another coincidence run in which the fixed channel was placed at 0.7 Mev. Since no coincidences were observed at 2 Mev, the 0.7-Mev gamma-ray must be in coincidence with the 1.4-Mev gamma-ray. The marked inequality of the intensities of these gamma-rays is in general agreement with earlier indications that the beta-spectrum is complex.[3] The 2.0-Mev gamma-ray presumably represents the cross-over transition.

A final set of energy measurements was made with a Hofstadter-type two-crystal spectrometer.[5] Since the coincidence counting