Bay and Szepesi, and Jordan[4] have been experimental studies in the gamma-ray region. However, these latter results are not sufficiently accurate to provide a conclusive test of the Klein-Nishina formula. Recent developments in counting gamma-rays with scintillations make possible a more accurate experimental investigation of the angular scattering in the Compton effect. The preliminary results of such a study are presented below.

The apparatus used in this experiment has been briefly described previously.[5] A sketch of the main features appears in Fig. 1. The quantity measured in the experiment is the number of coincidences between the recoil electron (counted by the "scatterer") and the scattered photon (counted by the "detector"). The number of coincidences has been studied as a function of the angular position of the detector. This number is corrected for the detector's efficiency and may be directly compared with the theoretical functions.

The source in this experiment has been a 20-millicurie Co^{60} rod of dimensions $\frac{1}{8}$ inch diameter, $\frac{3}{8}$ inch length. Co^{60} gamma-ray lines are present in equal strength and are of energies 1.169 and 1.331 Mev. The collimating channel is 10 inches long and of $\frac{1}{8}$-inch $\times\frac{1}{8}$-inch cross section in lead. A $\frac{1}{2}$-inch stilbene cube serves as scatterer and the detector is a block of stilbene $\frac{1}{2}$ inch$\times\frac{1}{2}$ inch $\times 1$ inch. In this experiment the distance between scatterer and detector is 11.6 cm. The crystals as well as the 1P21 photo-multipliers are carefully selected, and in operation the detector photo-multipliers are cooled to dry ice temperature. A $\frac{1}{16}$-inch aluminum sheet is placed between the scatterer and detector to isolate the detector from any scatterer recoil electrons. The coincidence method uses an oscilloscope viewed by an auxiliary counting photo-multiplier (not shown) and will be described elsewhere.

Forty-eight measurements of the number of coincidences per 200 seconds were made at each angular position examined. Plateaus in counting rate indicated that all scattering events were counted at each angular position except 20° and 15° where plateaus were not obtained. The number of events missed at 20° was probably not greater than 10 percent, however. In Fig. 2, which shows results obtained, the counting rates were corrected for the efficiency of the stilbene detector crystal which varies with the energy of the scattered photon. The well-established experimental total cross sections were used to make this correction. Other corrections applied to the experimental points in Fig. 2 have been made for: (*a*) the varying amount of absorption in the scatterer crystal which depends on the path traversed and photon energy and, hence, on the angular position of the detector; (*b*) the absorption of the scatterer photo-multiplier (glass envelope and contents) also in the path traversed by the scattered gamma-ray in some angular positions; and (*c*) the absorption of the thin-walled aluminum housings surrounding scatterer and detector

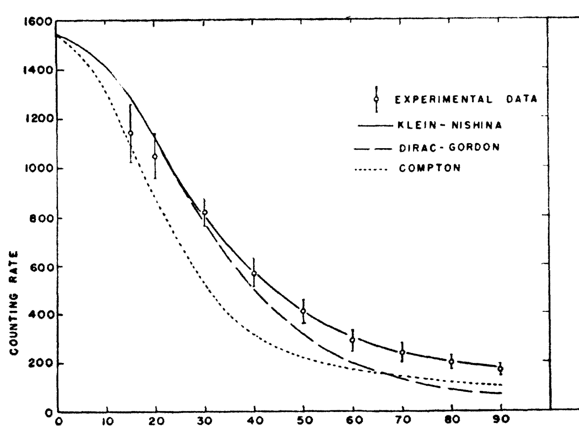

FIG. 2. Comparison of experimental and theoretical curves.

photo-multipliers as well as the absorption of the $\frac{1}{16}$-inch aluminum sheet isolating the detector from scatterer electrons. The sum of corrections (*a*), (*b*), and (*c*) amounts to 9 percent at 20°, 21 percent at 50°, and 30 percent at 90°.

The theoretical curves plotted in Fig. 2 are the sums of the angular distributions of scattered photons for each of the two Co^{60} gamma-rays. The strength of the source is known to only about 15 percent, and the normalization of the experimental curve has, therefore, been made with the closest theoretical Klein-Nishina curve within this 15 percent range. The Klein-Nishina curve is seen to fit the data much better than the older Compton and Dirac-Gordon curves. Further improvements in the experiment which will eliminate corrections (*b*) and (*c*) and determine absolute source strength are contemplated. The former improvements will reduce the total corrections to 9 percent at 50° and 11 percent at 90°.

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The Electromagnetic Separation of the Isotopes of Mercury

C. P. KEIM*
Carbide and Carbon Chemicals Corporation, Y-12 Plant, Oak Ridge, Tennessee
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THE natural isotopes of mercury have been enriched successfully in the mass spectrographs (calutrons) at the electromagnetic separation plant, Oak Ridge, Tennessee. Effort has been directed toward obtaining an enriched even-mass isotope with low odd-mass contamination, to minimize the isotope wave-length shift in the mercury spectrum, particularly the 5461A line. For this purpose the enriched sample of Hg 202, shown in Table I, has

TABLE I. Enriched and natural abundances of Hg isotopes in the sample of Hg 202.

Isotope	Enriched abundance	Natural abundance
Hg 196	0.014 percent	0.16 percent
Hg 198	0.092	10.02
Hg 199	0.113	16.92
Hg 200	0.781	23.10
Hg 201	0.365	13.22
Hg 202	98.06	29.72
Hg 204	0.574	6.84

been obtained. In this product the sum of the odd mass isotopes is 0.478 percent and the sum of the even mass isotopes is 99.522 percent.

In addition to the Hg 202 collection, Hg 198 has been enriched to >60 percent, Hg 199 to >70 percent, Hg 200 to >75 percent, and Hg 204 to >92 percent. Hg 196 and Hg 201 are still in process at this writing. Isotopic mixtures of high single isotope concentration are available on allocation from the Isotopes Division, Atomic Energy Commission, Oak Ridge, Tennessee.

The high purity Hg 202 reported in this letter has been examined in our spectroscopy laboratory by J. R. McNally, P. M. Griffin, and L. E. Burkhart and its characteristics are being discussed in a companion Letter to the Editor of the Journal of the Optical Society of America.

The successful enrichment of these mercury isotopes is the result of the cooperative efforts of the personnel of the Isotope Development Department. The contribution of the calutron crews, engineers, and shops are appreciated. These groups most directly associated with isotope production problems are under the supervision of H. W. Savage, B. S. Weaver, and P. J. Hagelston. W. E. Leyshon and L. O. Love deserve particular credit for their contributions to the solution of the difficult calutron problems. All isotopic analyses on natural and enriched mercury were done in the mass spectrometer laboratory under the direction of R. F. Hibbs and J. W. Redmond.

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* Superintendent, Isotope Development Department, Y-12 Plant, Carbide and Carbon Chemicals Corporation, Oak Ridge, Tennessee

A Preliminary Note on Nuclear Periodic Scheme in Three Dimensions

S. PODGOR
NEPA Division, Fairchild Engine and Airplane Corporation, Oak Ridge, Tennessee
August 19, 1949

IT appears to be well established that 2, 8, 20, 50, 82 numbers of neutrons or protons and 126 neutrons form particularly stable configurations.[1,2] In order to illustrate better how the properties of nuclei vary and to aid in discovering periodicities that exist, it seems worth while to arrange a nuclear periodic scheme analogous to the atomic periodic chart. However, since in the ordinary nuclear chart the isotopes proceed along two dimensions, the nuclear periods will have to advance along the third dimension.

It might be well to emphasize at this point that the properties of a nucleus are functions of two variables: Z, the number of protons, and N, the number of neutrons. Any particular nucleus, for instance, may have a complete shell in Z, but not necessarily in N, and conversely. Within limitations, there is then some independence in the variation of Z and N, and in the completion of shells in each of these variables.

We can build up the system with the assistance of a Segré chart, as illustrated in Fig. 1. It consists of successive planes; each plane starts with nuclei having a complete shell in either neutrons or protons, and ends with nuclei of the next complete shell in either nucleon. Only the first three planes are shown on the diagram.

Stable nuclei are indicated by cross-hatching; radioactive nuclei have the half-life on clear background; nuclei with a complete shell in either neutrons or protons are enclosed in heavy lines. Nuclei that are complete in both neutrons and protons ($_2He^4$, $_8O^{16}$, $_{20}Ca^{40}$) are darkened.

The complete scheme can be outlined as follows:

Plane I.—This consists of all nuclei up to those having a complete 2-shell in either neutrons or protons, or including the isotopes of He.

Plane II.—This starts with nuclei having 2 neutrons or 2 protons, and ends with a complete 8-shell in either nucleon, or including the isotopes of oxygen and F^{19}.

Plane III.—Similarly, this starts with all nuclei with 8 neutrons or protons, and ends with a complete 20-shell in either nucleon. After this, the neutron and proton periods proceed independently.

Plane IV.—This goes from nuclei with 20 nucleons of either type to nuclei with 50 protons, or the isotopes of Sn.

Plane V.—From nuclei with 50 neutrons to those with 82 neutrons.

Plane VI.—From the isotopes of Sn to nuclei with 82 protons or 126 neutrons (the isotopes of Pb and all nuclei with 126 neutrons).

Plane VII.—This goes from 82 protons or 126 neutrons, and includes all the remaining radioactive nuclei.

This arrangement should be very suggestive in bringing together species that have similar properties since it will tend to line up nuclei that are at the same stage of starting or completing a shell

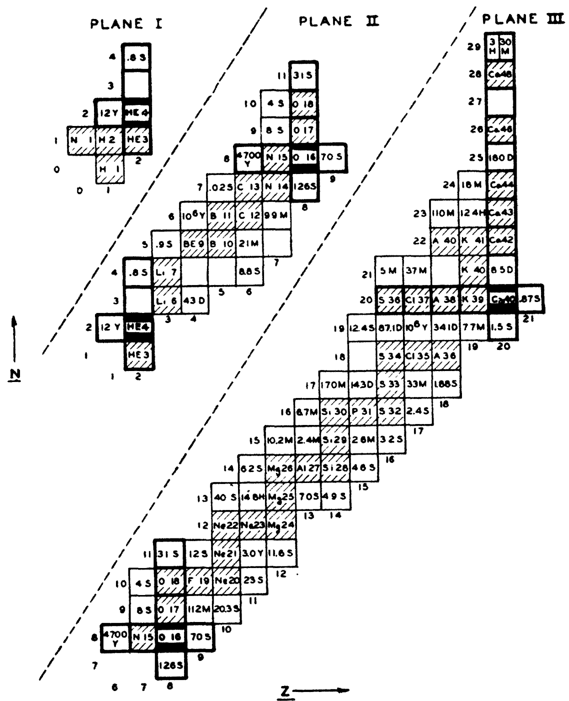

FIG. 1. Nuclear periodic scheme.

in either neutrons or protons. For instance, nuclei lacking one neutron to form a complete shell should have related properties; similarly for nuclei with one neutron more than a complete shell.

As an example of the use of this scheme, we may consider the following: $_8O^{17}$,[3] $_{36}Kr^{87}$,[1] $_{54}Xe^{137}$ [1] are known delayed neutron emitters. They have 9, 51, 82 neutrons, respectively, or one neutron more than a closed shell. They decay by neutron emission to $_8O^{16}$, $_{36}Kr^{86}$, $_{54}Xe^{136}$ all with closed shells in neutrons, $N=8$, 50, 82.

In our scheme they appear on Planes II, IV, VI, respectively. One would expect that there should be a neutron emitter in a corresponding place on Plane III at $N=21$. This might perhaps be $_{16}S^{37}$, decaying to $_{16}S^{36}$, ($N=20$). It would then be analogous to $_{36}Kr^{87}$ and $_{54}Xe^{137}$ since they decay to stable nuclei of lowest Z consistent with a complete neutron shell.

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The Beta-Spectrum of Be^{10}

H. W. FULBRIGHT AND J. C. D. MILTON
Palmer Physical Laboratory, Princeton University, Princeton, New Jersey
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THE beta-decay of Be^{10} has a particular interest at this time because the transition $Be^{10}\rightarrow B^{10}$ is now known almost certainly to involve a spin change of three units, so that the transition is highly forbidden according to the Fermi theory of beta-decay. Marshak has shown[1] that the Fermi theory predicts an energy spectrum for the Be^{10} beta-rays which is substantially different from the allowed form. He gives a set of curves of correction factors for converting the allowed spectrum into other forms corresponding to the different types of transitions which theoretically might apply to this case. By arguments based on the half-life, he narrows the choice down to one curve (D_2). The D_2 curve corresponds to second- or third-forbidden tensor or second-forbidden axial vector type transitions if Gamow-Teller selection