second. The second alpha counter would be a thin (slightly more than alpha range) layer of plastic scintillator on the glass envelope of a short-transit-time photomultiplier. This (coincidence and time zero) counter would be movable within the vacuum system to provide a coincidence neutron beam over a 120° range of angles, all directed away from the laboratory building. The scatterer would be outside the vacuum system. To cut down random background from cosmic rays, an array of Geiger counters in anticoincidence would shield the neutron detector.

Analysis would be carried out by a chronotron similar to the one already built, but with a channel width of 2×10^{-9} second to take advantage of the short-transit-time photomultipliers.

Estimates of the backgrounds to be expected indicate that 1000 counts/hour could be collected on a line having 2 percent of the total INS intensity, with a real-to-random ratio of 1:1. Since the main source of background would be random n-alpha coincidences, the true/background ratio could be improved in direct proportion to the time required to collect a specified number of counts. Energy resolution would be ~10 percent (full width) at 12 Mev, with a three-meter flight path.

It should be emphasized that the discussion above is the summary of a design study, not a description of apparatus already built or definitely planned.

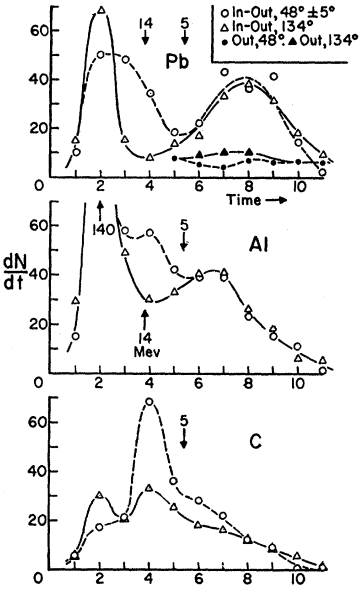

FIG. 7. Energy distributions, with backgrounds subtracted, at two angles for each of three elements. The first peak in each case is ascribed to gamma rays. The arrival time for 14-Mev elastically scattered neutrons is indicated on the graph for Al.

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Natural Radioactivity of Sm^{147}

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The half-life of Sm^{147} has been measured to be $1.25\pm0.06\times10^{11}$ years with an energy distribution corresponding to the emission of monoenergetic alpha particles.

A STUDY of the natural radioactivity of Sm^{147} has been made, including a determination of the half-life and an investigation of the energy spectrum of the alpha particles.

The activity of the samarium was measured using a 4π counter developed by Sawyer and Wiedenbeck.[1] The counter was originally designed for use in the Geiger region, but tests showed that with center wires of 4-mil diameter and a filling of 20 cm of CH_4 and 41 cm of argon it performs satisfactorily in the proportional region also. The sources were made of zapon films upon which aluminum was deposited by evaporation in a vacuum followed by a similarly deposited layer of samarium chloride. It was found that by using a molybdenum crucible quite efficient evaporation of the samarium chloride could be obtained.

When samarium chloride is evaporated, there is some question as to its final chemical composition.[2] Therefore, in order to determine the amount of samarium deposited, a spectroscopic analysis of each source was made.

A large quantity of 10 percent HCl stock solution

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[2] L. L. Quill, *Nuclear Energy Series IV 19B* (McGraw-Hill Book Company, Inc., New York, 1950), pp. 125, 219.

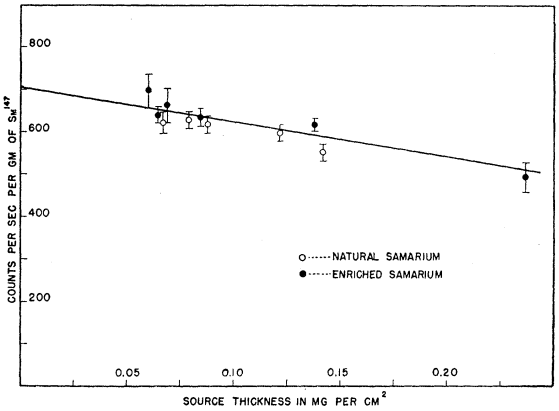

FIG. 1. Counting rate *versus* total source thickness.

was prepared with 15 mg per cc of Cu to act as the internal control, and from it several standards were made by adding known amounts of Sm_2O_3. After the activity of a source had been measured to within a probable error of 2 percent, the zapon film was immersed in a known quantity of the stock solution which dissolved the samarium chloride and aluminum. A large Littrow prism spectrograph was used with a spark source and the spectra recorded on a SA No. 1 photographic plate. By comparing the relative densities of the Cu control line at 3602.0 A and the Sm line at 3609.5 A, the concentration of the Sm in the sample was determined. In the best runs the accuracy was judged to be within 3 percent.

Both natural and enriched Sm were used as sources. The natural[3] Sm with 15.07 percent Sm^{147} was about 98 percent pure[4] Sm_2O_3 and the enriched[5] Sm with 78.35 percent Sm^{147} was over 99.6 percent pure Sm_2O_3.

Figure 1 shows the variation of the counting rate with the total source thickness. After extrapolation to zero thickness and application of a 2 percent correction to compensate for the counter inefficiency, one finds a counting rate of $7.19\pm0.36\times10^2$ counts per second per gram of Sm^{147}. This corresponds to a half-life of $1.25\pm0.06\times10^{11}$ years, a value somewhat lower than most results obtained in the past, particularly those which involved a measurement of the total number of tracks produced in a nuclear emulsion.[6–9]

To investigate the energy spectrum, 0.9 mg of enriched samarium chloride was evaporated onto a thin zapon film giving an average source thickness due to the samarium chloride of 0.008 mg/cm^2. The zapon film was then placed in contact with a fresh Eastman NTA 25 micron nuclear plate. After three weeks the plate and a blank control were examined. When a shrinkage factor of 2 was applied,[10,11] some 175 tracks were left which satisfied the criterion that their original penetration angles be less than 37.5°. Under these conditions an error of as much as 10 percent in the shrinkage factor would affect the length measurements by a maximum of about 4 percent. The resulting mean track length of 7.0 microns agrees with other nuclear emulsion measurements,[6,7,12] and the distribution shows that at least the large majority of the alpha particles are surely emitted at one energy which is also in agreement with previous work.[6,13,14]

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