essential agreement with a value reported by Becker and Kirn[6] who obtained as a "preliminary" value 2.80±0.05 Mev. This value was determined by spectrometric means.

In analyzing this data the range-energy curve for the absorption of electrons in aluminum as given in *The Science and Engineering of Nuclear Power*,[7] was used. All beta-spectra analyzed to date have indicated that this is the most reliable range-energy curve.

The above method of curve analysis may be used to obtain the end-energies of complex spectra. A paper is in preparation outlining the method in detail and giving further examples.

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Photo-Disintegration of Rhodium*

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ANGULAR and energy distributions of protons from nuclei disintegrated by collimated x-rays produced with a 20-Mev betatron have been studied, some preliminary results of rhodium disintegrations being presented here.

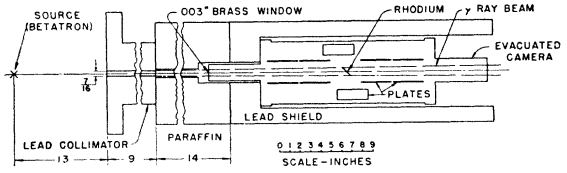

FIG. 1. Experimental arrangement, schematic.

A diagrammatic sketch of the apparatus is shown in Fig. 1. Alignment was checked optically and with x-ray shadowgraphs. Particles emitted from the target enter photographic emulsions (200μ Ilford) in an evacuated "camera." Only those tracks beginning at the surface are measured; neutron-proton recoil tracks originating in the body of the emulsion are sparse enough and evenly enough distributed so that they contribute negligibly to surface tracks, which are observed to have the correct directions for the protons to originate in the target. Energies are evaluated by the usual range relationship[1] and are corrected for loss in the 0.025-mm target.

TABLE I. Ratios of small-angle to right-angle intensities.

Proton energies, Mev	3.5–5.5	5.5–7.5	7.5–9.5	9.5–11.5
Ratios	0.69±0.14	0.75±0.10	0.54±0.10	0.23±0.08

Figure 2 shows histograms of observed intensities I (=number of protons per hundredth steradian) for 3 plate positions, 20° (forward)±7°, 90°±12°, and −20° (=160°)±7°, the factor to convert I to N, the number of observed tracks, being stated on each histogram. Fore and aft intensities do not differ within present statistical errors, but right-angle emission predominates over emission at small angles, particularly at the higher proton energies. The small-angle intensity is averaged from the fore-and-aft positions and its ratio to right-angle intensity is shown in Table I.

Some such angular asymmetry might be expected from either of the dipole theories,[2,3] though the effect has yet to be estimated quantitatively, either with these or the compound-nucleus models.[4]

A similar irradiation with a heavy paraffin target served to check the betatron x-ray spectrum[5] which, with the theoretical deuteron cross sections,[6] is consistent with our observed proton spectrum. From the upper limit of the x-ray energies and the highest energy rhodium proton tracks on the 90° plate, a threshold of 8±1 Mev is obtained. By comparing intensities on the 90° plates from the two targets (monitoring the beam with an ion chamber), it is found that the rhodium γ-p cross section is 4.0±0.5 times the deuteron γ-p cross section for the 15–20-Mev gamma-energy range. Using the value from the symmetrical theory for the deuteron cross section[7] at 17.5 Mev and 90°, then, with the foregoing rhodium—deuteron ratio, the rhodium cross section for 17.5±1.0 Mev and 90° comes out to be $3.6(\pm0.5)\times10^{-28}$ cm²/sterad. With this value and with the observed angular distribution, the integral cross section for the same energy is $3.5(\pm0.6)\times10^{-27}$ cm². These cross sections apply to disintegration into a normal Ru^{102} nucleus; that excited states of the latter are not much involved in disintegrations by 15—20-Mev gamma-rays is

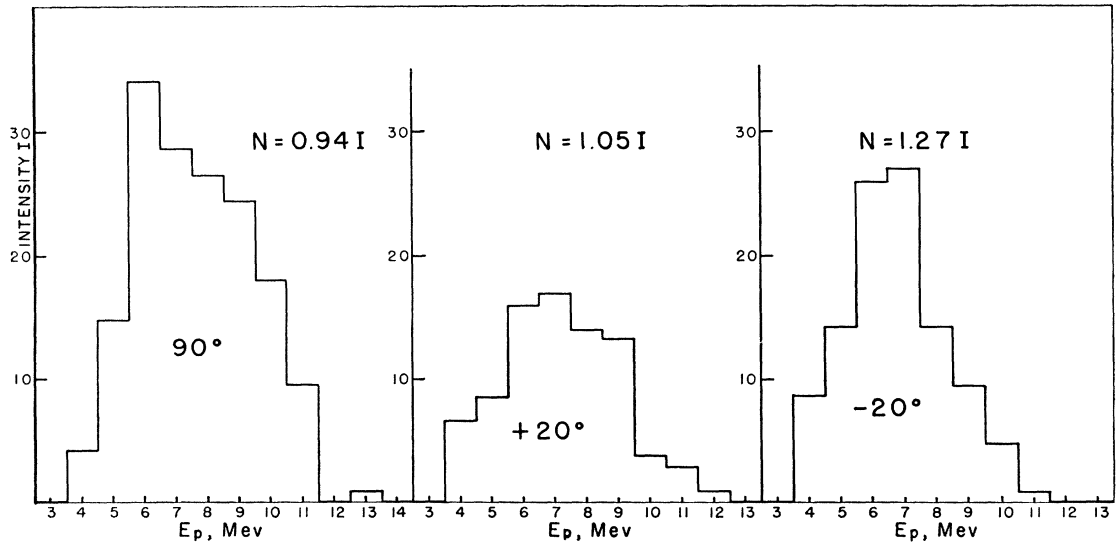

FIG. 2. Proton intensities as a function of proton energy, Ep.

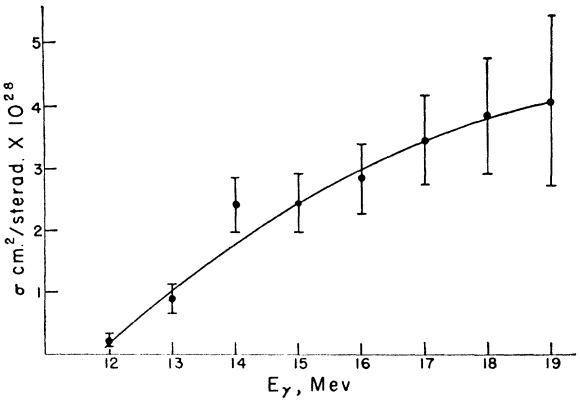

FIG. 3. Cross sections for proton emission at 90° as a function of γ-ray energy.

implied by the closeness of this value to the total photo-proton cross sections of neighboring elements determined by the radioactive-product method.[8]

With the threshold, the 90° cross section and the betatron intensity spectrum, the 90° excitation curve, calculated for a normal product nucleus, is shown in Fig. 3.

An upper limit to the neutron flux from the betatron was obtained in the heavy paraffin irradiation. Upper limits to Rh n-p cross sections at large and small angles were determined for 11–14-Mev neutrons, with coincidence proportional counters.[9] These values show that only a negligible fraction of our observed protons could come from an n-p reaction.

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A Delayed Coincidence Counting Measurement of $Hg^{203,205}$*

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AN attempt has been made to measure the half-life of the γ-ray in the beta-gamma-cascade emission from $Hg^{203,205}$ by a delayed coincidence measurement. The experimental arrangement makes use of a proportional counter as the beta-ray detector and a 931A photo-multiplier tube with an anthracene crystal as the gamma-detector. A resolution curve for the detectors and coincidence circuits was obtained by sending beta-rays from a P^{32} source through the proportional counter into the anthracene scintillation counter. The resulting plot of coincidence counting rate *versus* delay (placed in either channel) resulted in a symmetrical curve with a half-width of 7×10^{-8} sec.

The $Hg^{203,205}$ source was placed between the two counters with an absorber to stop the beta-rays from entering the scintillation counter and a similar curve taken. A compilation of two runs is shown in Fig. 1, and the curve is quite symmetrical. An upper limit for the half-life may be obtained by using theoretical expressions[1] for the coincidence *versus* delay curves. Increasingly larger

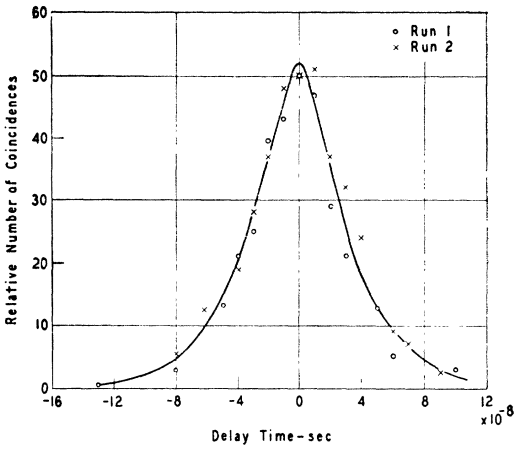

FIG. 1. Coincidence counting rate *versus* delay curve for the $Hg^{203,205}$ decay.

values for the half-lives were inserted in these expressions until a distinct asymmetry appeared in the curve. This occurred at 2×10^{-8} sec., which is then the upper limit.

From the work of Inghram, Hess, and Hayden,[2] the observed activity is probably due to Hg^{203}. Using this fact and the γ-ray energy given by Saxon[3] in Segré's formula,[4] an upper limit for the l-change may be determined. For $\Delta l=2$, the computed half-life is 9×10^{-10} sec., and for $\Delta l=3$, 2×10^{-5} sec. The l-change is thus not greater than 2, in agreement with Saxon's value[3] of 2 from the ratio of K and L conversion coefficients.

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Coherent Neutron-Proton Scattering by Liquid Mirror Reflection*

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THE importance of the coherent scattering of slow neutrons by protons in the determination of the range of nuclear forces has been emphasized recently by Blatt,[1] Blatt and Jackson,[2] and Bethe.[3] These authors show that the main uncertainty in the determination of the singlet as well as the triplet n-p range is the coherent n-p scattering. The coherent scattering has been measured with an accuracy of three percent in the parahydrogen experiment[4] and slightly less accurately by the scattering from hydrogen in crystals.[5] The former experiment contains a possible additional systematic error caused by the presence of orthohydrogen and the latter experiment possesses the uncertainty of the correction for temperature diffuse scattering (which lessens the observed coherent scattering). About a year ago, when plans for a repetition of the parahydrogen measurement were being considered, Hamermesh[6] and Wattenberg suggested that the coherent hydrogen scattering might be measured with the neutron mirror techniques then in use at Argonne Laboratory.[7,8] Hamermesh pointed out that the coherent scattering amplitude could be obtained from the critical angle of a hydrogen mirror with no theoretical uncertainty (no effect of inelastic scattering because only forward scattering is involved in glancing reflection), but