UNIVERSITY OF CALIFORNIA

Radiation Laboratory

BERKELEY, CALIFORNIA

Copy 2

UCRL-386

Unclassified Distribution

UNCLASSIFIED

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Contract No. W-7405-eng-48

SUMMARY OF THE RESEARCH PROGRESS MEETING

July 7, 1949

H. P. Kramer

Berkeley, California

Summary of the Research Progress Meeting

July 7, 1949

H. P. Kramer

Internal Conversion in Polonium. L. Germain

It was suggested by E. Segrè that the decay of At^{211} presents a convenient scheme for the measurement of an internal conversion coefficient. The disintegration of At^{211} proceeds as shown in the diagram of Fig. 1. About forty percent of the nuclei transmute by 7.5 hr. 5.9 Mev α-emission to Bi^{207} and about 60 percent of the nuclei are transformed to Po^{211} by K-capture. Po^{211} in turn decays by 5×10^{-3} sec. 7.4 Mev α-emission to the stable isotope Pb^{207}. The α-daughter, Bi^{207}, is suspected also to decay to Pb^{207} by K-capture but if this transmutation occurs, the radiation that is emitted is so slight that it has been impossible to detect it. The At^{211} that was used was produced by the Bi(α,2n) reaction with the 184-inch cyclotron.

R. Leininger, who performed the chemical separation, reported that the elimination of both Po and Bi from the sample was quite successful.

A drop of As^{211} in solution was placed on the emulsion of a Kodak NTB-3 plate which was then dried rapidly to avoid as much as possible a swelling of the emulsion which would make precise range determinations impossible. The difference in energy between the two α-disintegrations that occur is sufficient to permit a discrimination by the length of track in the emulsion. The 5.9 Mev radiation has a range of 25 microns and the 7.4 Mev activity leaves a track of about 35 microns in the emulsion.

The 7.4 Mev α-track that appears in the disintegration of Po^{211} may or may not be joined to a 60-90 Kev, 25-30 micron, electron track depending on whether or not a conversion electron was emitted during the decay of At^{211} by K-capture. 171 electron-α coincidences and 1849 α tracks with K X-rays were observed. These results yield a value

for the internal conversion coefficient 171/1849 = 9.25 $\pm$ 0.5 percent.

During a short critique following the description of the work, it was pointed out that there was no assurance that the electrons that were observed were produced exclusively by the internal conversion of K-capture X-rays but that Auger electrons might also have been observed and included in the ratio. The possibility that some of the electron tracks that were counted were produced by the conversion of L X-rays was ruled out because of the low calculated energy of these electrons and hence the shortness of the tracks that they might leave in the emulsion.

Total Neutron Cross Sections at 280 Mev. R. Fox

The apparatus for the measurements is shown in Fig. 2. In those cases where it was not convenient or possible to expose the target element in a pure form, two substances of which one contained the target material in a known amount and of which the other did not were bombarded and the result for the pure target element was obtained by subtraction. For example, the total cross section for deuterium was found by the successive measurement of the cross sections of heavy and ordinary water and the cross section for protons was found by using pentane and then carbon. The copper absorber between the two scintillation counters in coincidence was 2 in. in length and thus served to limit the coincidences counted to those caused by neutrons with energy in excess of 250 Mev.

The high voltage bias on the counters was such that only protons were counted.

The accidental count was checked by inserting a tungsten absorber between the coincidence counters several mean free paths in length so that no protons of energy less than 350 Mev could pass through it. Also the scatterer was removed so that air scattering was counted as a measure of background. The background that was obtained in this manner never amounted to more than 1 percent in the case of the light elements and about 5 percent for the heavy elements. During the early stages of the experiment it was found that protons were coming directly from the attenuator into the counters. By inserting a lead shield this radiation was stopped and the background was decreased by 60 percent.

Fig. 3 displays the experimental results as a plot of $R = \sqrt{\frac{\sigma}{2\pi}}$ against $A^{1/3}$. Fig. 4 shows a graph of the cross section per nucleon as a function of $A^{1/3}$. The ordinates in the graphs corresponding to Al, Sn and U are misrepresented in the graph and should be greater.

High Energy Neutron Cross Sections. S. Fernbach.

In UCRL-262, "The Scattering of High Energy Neutrons by Nuclei", S. Fernbach, R. Serber, T. B. Taylor, December 28, 1948, the speaker presented an attempt to interpret the scattering of high energy neutrons by means of a pseudo-optical model of the nucleus. The model gave results that are in good agreement with experiment for 90 Mev neutrons. Work has been continued on the model to test its agreement with experiment at an incident neutron energy of 280 Mev.

The nucleus is thought of as a transparent sphere of uniformly dense material characterized by a coefficient of absorption K and an index of refraction k_1. For the index of refraction k_1 the relation

$$k_1 = k \left[(1 + V/E)^{1/2} - 1 \right]$$

was set up. At 90 Mev the value that was determined by taking V, the potential inside the nucleus, equal to 30 Mev was $k_1 = .33 \times 10^{13}/\text{cm}$. At 280 Mev it was found that a value of $V = k_1 = 0$ would give the best fit to the experimental data. However, even with this value for k_1 the agreement with the experimental results was not satisfactory.

An improvement was made by expressing K, the absorption coefficient, in the form $K = aZ/A + b$, with $b = 0$. The predicted values now agree fairly well with the experimental data for high mass numbers.

Proposed Experiment for the Determination of the Neutron-Neutron Scattering Cross Section. G. Chew.

An impromptu suggestion was offered to the meeting about a possible method for measuring the neutron-neutron cross section by the bombardment of deuterium with neutrons. It is contemplated that the target is to be located in a cloud chamber so that tracks that are made by the protons that are emitted during a collision might be photographed. Fig. 6 shows a scheme of the target that a deuterium nucleus presents. If a proton is hit by a neutron, the proton is ejected in the forward direction and a corresponding track is seen, unless charge exchange takes place. When the neutron in the deuterium nucleus is hit, the proton is released with small energy and an isotropic distribution of direction of motion. Charge exchange is not a very serious impediment to the experiment since it occurs only about once in every 200 collisions. The ratio of the neutron-neutron cross section to the neutron-proton cross section will be measured by the number of tracks that have an isotropic distribution and the appropriate energy divided by the number of proton tracks in the forward directions.

INFORMATION DIVISION
7/25/49:hw

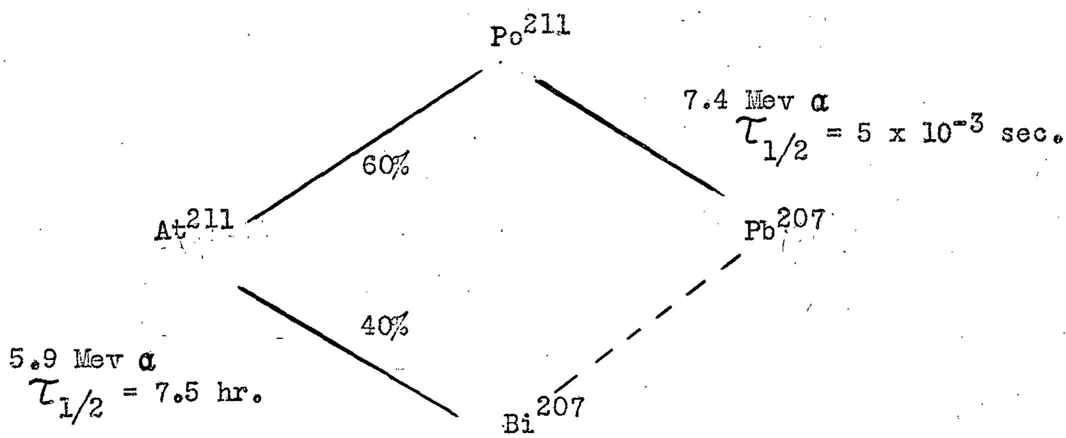


Fig. 1

Decay Scheme of At^{211}

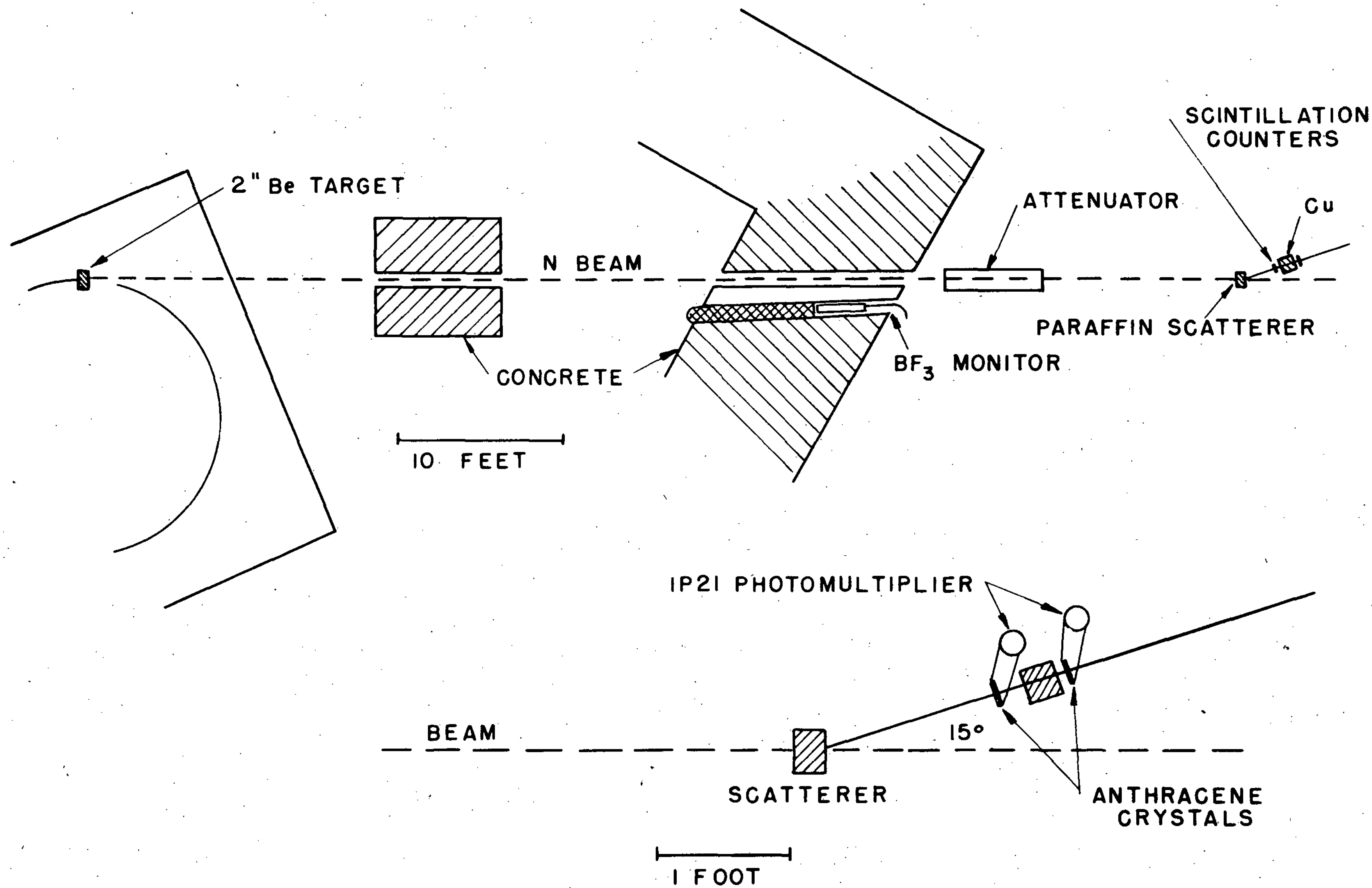
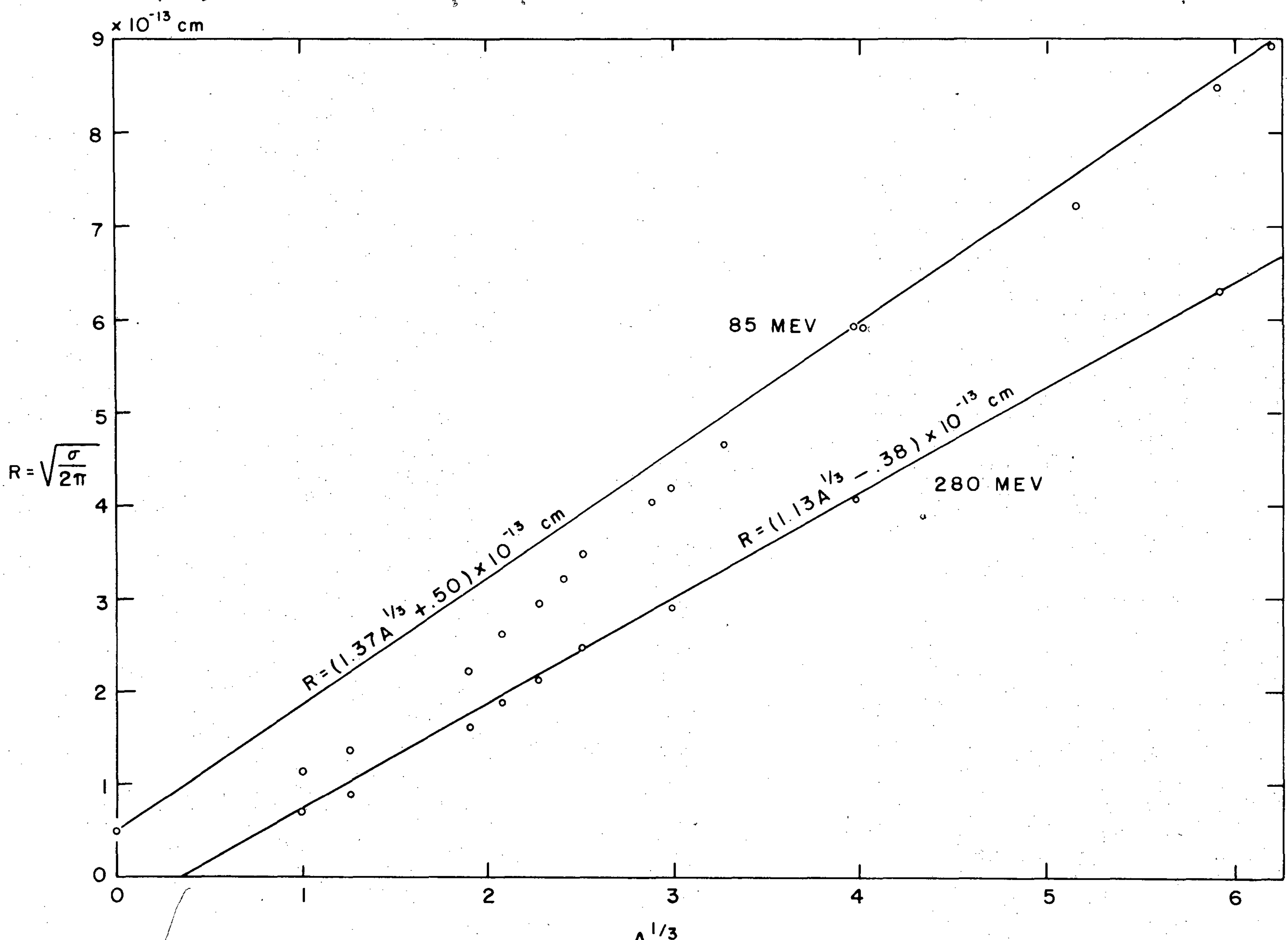

2" Be TARGET
N BEAM
ATTENUATOR
SCINTILLATION COUNTERS
Cu
PARAFFIN SCATTERER
CONCRETE
BF3 MONITOR
10 FEET
1P21 PHOTOMULTIPLIER
BEAM
15°
SCATTERER
ANTHRACENE CRYSTALS
1 FOOT

FIG 2



x 10^-13 cm
R = √(σ/2π)
85 MEV
280 MEV
R = (1.37A^1/3 + .50) x 10^-13 cm
R = (1.13A^1/3 − .38) x 10^-13 cm
A^1/3
0
1
2
3
4
5
6
7
8
9

FIG. 3

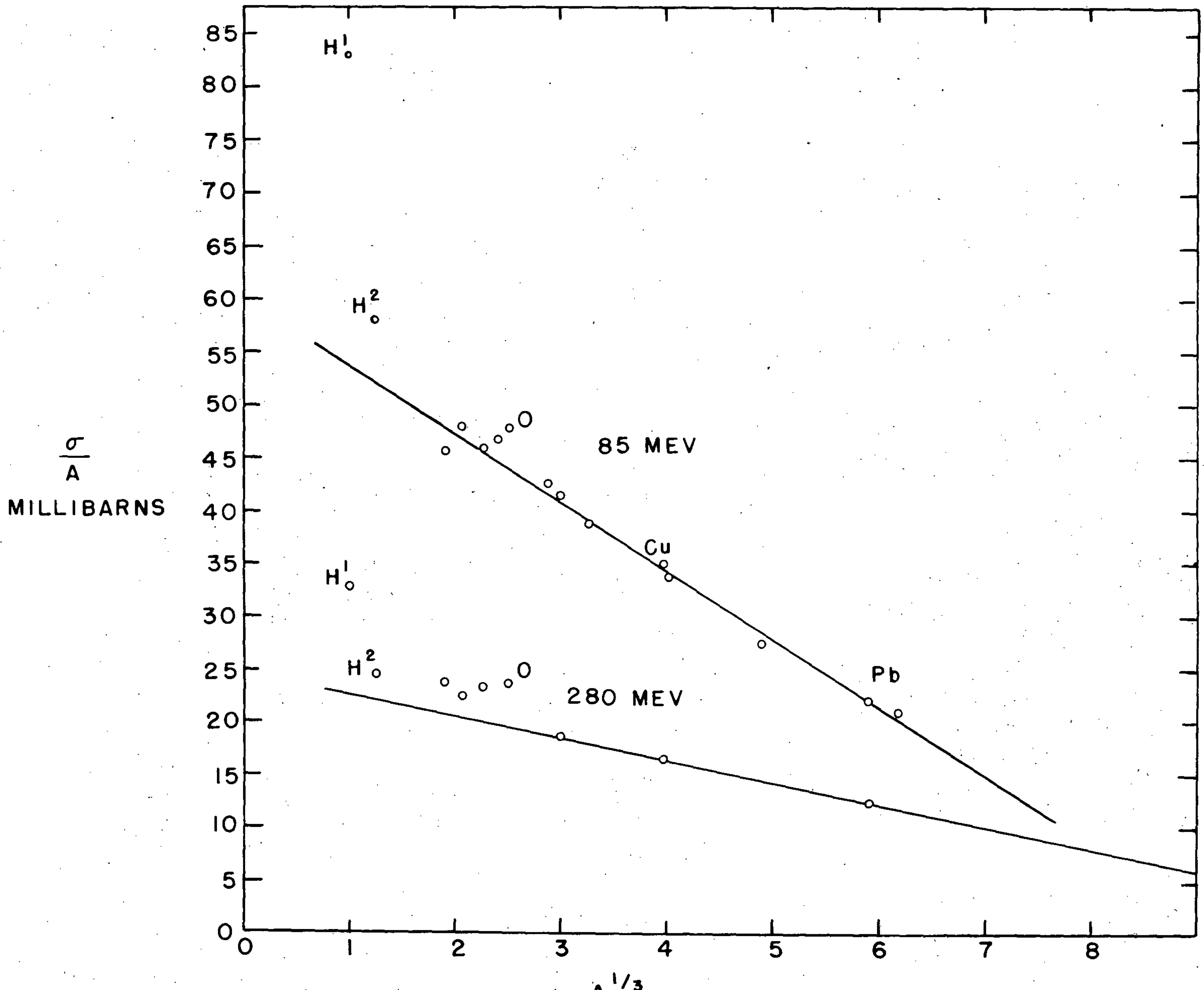

85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
H¹
H²
O
85 MEV
Cu
Pb
H¹
H²
O
280 MEV
σ/A
MILLIBARNS
A^1/3

FIG. 4

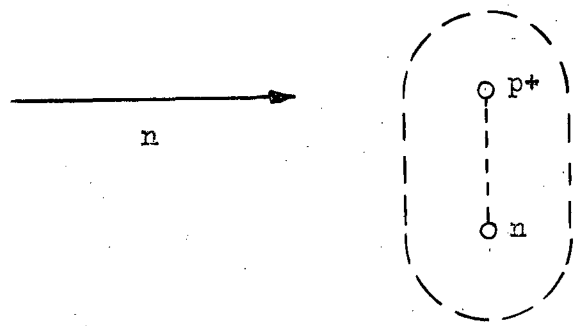


Fig. 5