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THE DEPENDENCE OF NEGATIVE PION PRODUCTION ON NEUTRON NUMBER

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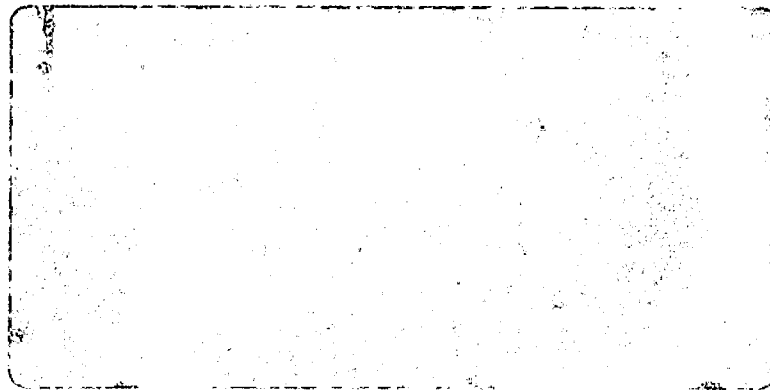
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Walter F. Dudziak and Ryokichi Sagane

August, 1953

Berkeley, California

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August, 1953

The existing data ^{1, 2} on positive pion production resulting from the interaction of 340 Mev protons with complex nuclei indicate that the production cross sections agree more closely with a $Z^{2/3}$ variation than with a variation proportional to Z . A question of interest is the study of negative pion yields from proton-nucleus collisions. A preliminary survey of negative pion production at two pion energies has been made for Be, C, Al, Cu, Ag and Pb, using the externally deflected 340 Mev synchro-cyclotron proton beam.

The proton beam was monitored by an (argon-filled) ionization chamber. It then passed down the axis of a 22 in. spiral-orbit spectrometer ¹ and traversed the target, which was positioned symmetrically about the median plane. Negative pions produced in the target at 90° to the proton beam were magnetically separated and focused at the stable orbit by the spiral-orbit principle. ³ For these experiments the pion energy at the stable orbit was $T_\pi = 9.2$ Mev. As a result a 10-mil. aluminum degrader was introduced to slow down the ($T_\pi = 12.5$ Mev) pions. For the degradation to the stable orbit energy of the ($T_\pi = 33$ Mev) pions a 230-mil copper degrader was used ¹ for Be, C and Al and a 140-mil copper degrader was introduced for Cu, Ag and Pb targets.

Hollow cylindrical targets having the following dimensions were used for the ($T_\pi = 33$ Mev) experiment:

- a) light elements (Be, C, Al): 3/4 in. O. D. ; 1/2 in. I. D. ; 1-1/2 in. long
- b) heavy elements (Cu, Ag, Pb): 3/4 in. O. D. ; 1/2 in. I. D. ; 1/2 in. long

Data from a carbon target having the same dimensions as those of the heavy elements were also obtained. These furnished the normalization factor which was necessary to take account of the difference in target geometry between the light and heavy elements.

For the ($T_{\pi} = 12.5$ Mev) experiment, hollow conical targets having an apex angle of 25° were used. In this case the external size of the cone was held constant and the wall thickness was varied, to take account of the difference in stopping power of the target material. Thus pion energy loss through the target was fixed to $\Delta T_{\pi} = 3$ Mev.

The pions were detected by C-2 (200 μ) Ilford nuclear emulsions. Since the developed emulsions were very clean (low background), they were scanned under oil with a magnification of 270.

Figure 1 is a plot of the data for $T_{\pi} = 12.5$ Mev. The pion yields per nucleus are plotted as a function of the number of neutrons ($N=A-Z$) in the nucleus because charge conservation prohibits negative pion production from a proton-proton type of collision within the nucleus. Similarly Fig. 2 represents the data from the $T_{\pi} = 33$ Mev. experiment. The uncertainties indicated in the data are statistical probable errors involved in the counting of pions.

Both figures indicate an $N^{2/3}$ variation, and also a variation proportional to N . These curves are normalized at the Ag point. The experimental data for the two pion energies are in better agreement with a variation proportional to N than with an $N^{2/3}$ variation. Since positive pion yields from collisions between protons and complex nuclei seem to favor a $Z^{2/3}$ variation one may infer from these preliminary data that the "mechanism" for production of positive and negative pions is not the same in proton-nucleus collisions.

We are grateful to Professors E. Lawrence, R. Thornton, W. Barkas and C. Richman for their aid in obtaining the funds for the spiral-orbit spectrometer as well as for their continued interest. We would like to acknowledge the cooperation of Jimmy Vale and the cyclotron crew in making the exposures.

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FIGURE CAPTIONS

- Fig. 1 Variation of the relative production cross section for $(T_{\pi} = 12.5 \text{ Mev})$ π^{-} -mesons as a function of the number of neutrons ($N = A - Z$) in the nucleus. An $N^{2/3}$ variation and a variation proportional to \dot{N} , both normalized at the Ag point, are superimposed on the data.
- Fig. 2 Variation of the relative production cross section for $(T_{\pi} = 33 \text{ Mev})$ π^{-} -mesons as a function of the number of neutrons ($N = A - Z$) in the nucleus. An $N^{2/3}$ variation and a variation proportional to N , both normalized at the Ag point, are superimposed on the data.

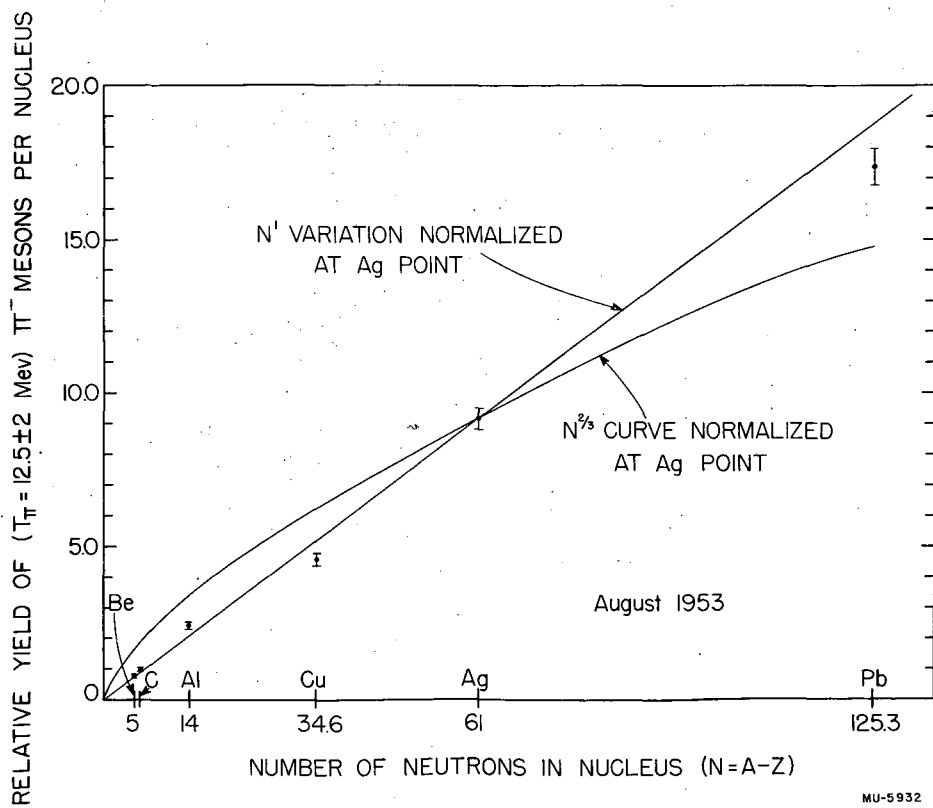


Fig. 1.

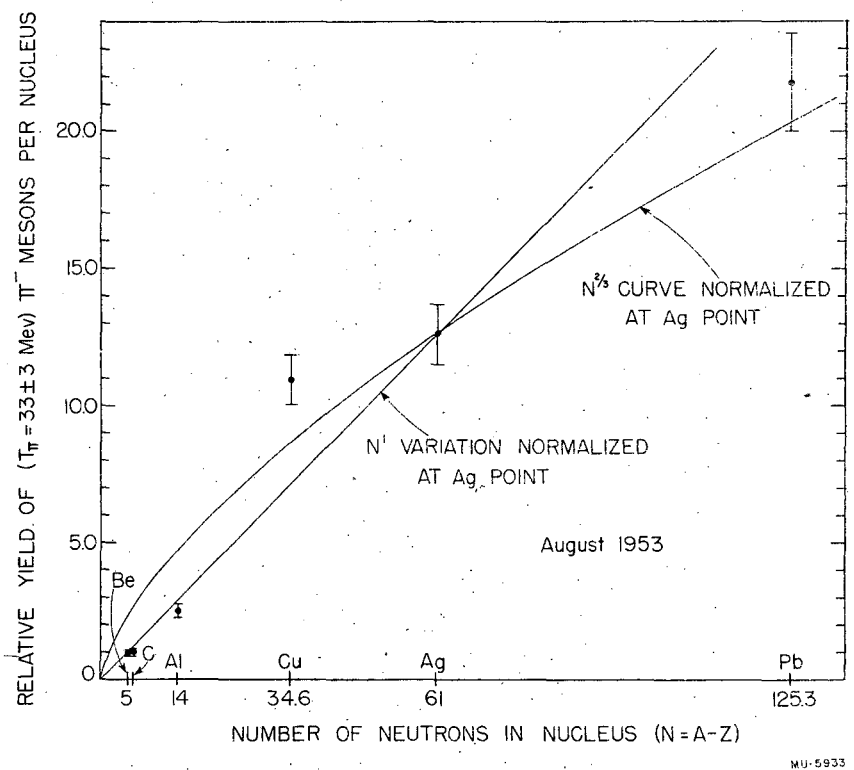


Fig. 2