Total Photonuclear Absorption in Al*

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A direct measurement of the total photonuclear absorption in Al was carried out with improved resolution using a Compton spectrometer for analysis of the bremsstrahlung and absorption spectrum. The maximum value for the cross section is found to be 100±10 mb; the integrated cross section is estimated to about 800 mb Mev.

THE total photonuclear absorption cross section has been in most cases determined by studying the contributions from the various partial reactions (γ,n), (γ,p), *etc.* Information obtained in this way is rather uncertain, especially in the region above the peak of the giant resonance. A direct measurement of the total absorption would be desirable. Such measurements have been performed using a NaI-crystal,[1] but they suffer from rather poor resolution.[2]

For this reason it seemed worth while to measure the total absorption in nuclei directly with a magnetic Compton spectrometer using a bremsstrahlung source. A pure Compton electron spectrum is obtained by subtracting the positron spectrum and the difference between electron and positron background from the observed electron spectrum. The Compton spectrum so obtained faithfully represents the x-ray spectrum except for a small energy shift and an energy-dependent efficiency factor which is immaterial for the present purpose. The absorption spectrum is determined by by comparing numbers of counts without and with absorber.

A stabilized[3] Brown-Bovery betatron has been used as the source of bremsstrahlung. The spectrometer used[4] had a resolution of the order of 1% and an efficiency (i.e., number of counts per number of incident x-ray quanta) of the order of 10^{-7}. The energy scale of the spectrometer has been calibrated by observing the high-energy end of the x-ray spectrum at several top energy values, fixed by known (γ,n) and $(\gamma,2n)$ thresholds. The absorber was a 485-mm long conical aluminum rod (maximum diameter 4 mm) which fitted into the hole of a lead collimator. An ionization chamber has been used as a relative monitor. It was placed in the collimated x-ray beam behind the spectrometer. The zero point of the cross-section scale has been determined by comparing at a certain setting of the spectrometer the counting rate with and without absorber, using

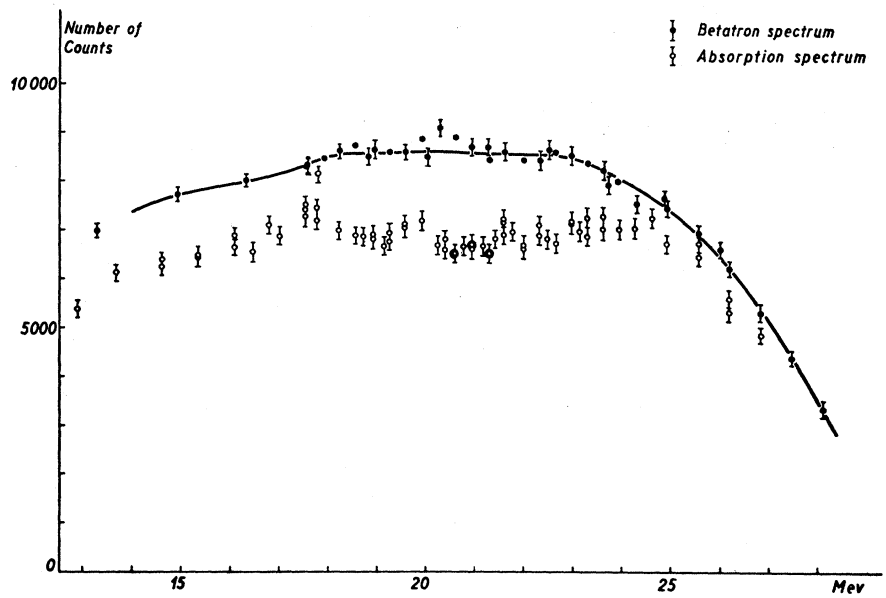

FIG. 1. Betatron spectrum and absorption spectrum.

* A preliminary result of this measurement was communicated at the Congress of Nuclear Physics, Paris, July 7–12, 1958, in the summary report on the photonuclear reactions given by Professor J. S. Levinger.

[1] R. S. Foote and H. W. Koch, Rev. Sci. Instr. **25**, 746 (1954).

[2] After the completion of this work an article has appeared by B. Ziegler, Z. Physik **152**, 566 (1958), in which the result of measurements of the photonuclear absorption, using a pair spectrometer, is presented.

[3] D. Jamnik, Nuclear Instr. **1**, 324 (1957).

[4] U. Miklavžič and Č. Zupančič (to be published).

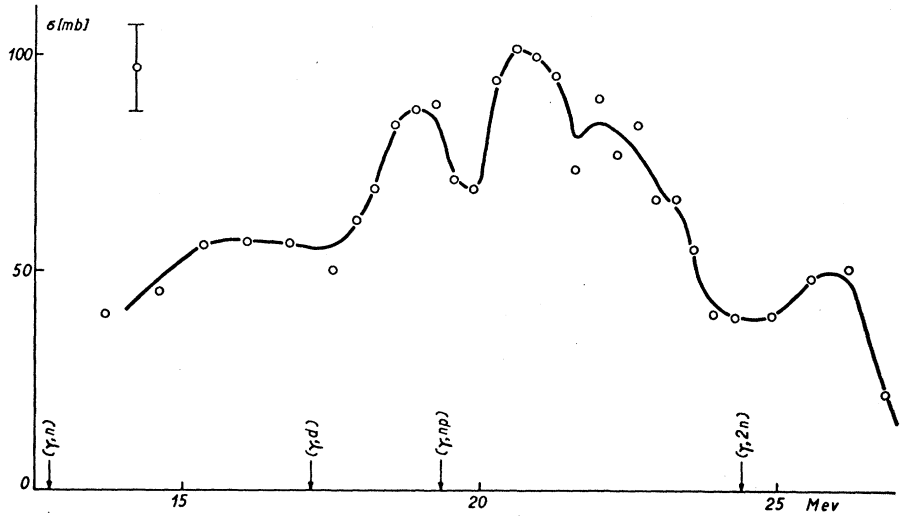

FIG. 2. Total photonuclear cross section in Al.

another ionization cell inside the betatron and outside the main beam.

The spectra are plotted in Fig. 1, where only statistical errors are indicated. An additional error of about 1% is due to the fluctuations in the experimental setup. (The measurements lasted for several weeks.) The spectrum without absorber was measured several times. The average is shown by the smooth curve whereas the dots represent only a typical run.

The photonuclear absorption cross section (Fig. 2) has been obtained by taking into account the averaged and smoothed results. The values near the peak of the cross-section curve are most certain, whereas increased systematic errors can be expected at the upper and lower end of the investigated region. In the region around 20 Mev a fine structure appears to be present, but the statistical errors prevent to draw a definite conclusion.

The atomic γ-ray absorption was taken into account numerically.[5]

The zero of the cross-section scale is believed to be uncertain up to 10 mb.

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[5] Ch. M. Davisson, in *Beta- and Gamma-Ray Spectroscopy*, edited by K. Siegbahn (North Holland Publishing Company, Amsterdam, 1955), p. 857.