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ABSTRACT

A counter experiment to measure the attenuation of K^+ mesons in various materials has been completed. From the attenuation cross sections measured by a transmission-type experiment and from the differential-scattering cross section for one angle, the real and imaginary parts of the potential have been calculated by use of the optical model.[1] A modification was made in the optical model by using the nucleon-density distribution determined by electron scattering experiments.[2] As previously reported the average real potential is 24.2 ± 2.3 Mev.[3] No attempt has been made to fit the data with an attractive potential. The cross section for protons is found to be 15.4 ± 3 mb. The average K-nucleon cross section in the elements with Z between those of carbon and lead, derived from the imaginary potential, is approximately 10 mb.

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INTRODUCTION

In a recent counter experiment we measured the attenuation cross section for K^+ mesons on carbon, aluminum, copper, silver, and lead.[1] The data were reduced in terms of the optical model of Fernbach, Serber, and Taylor[2] using a complex square-well potential to represent the interaction. This gave an average value for the real potential of 24.2 ± 2.3 Mev. The imaginary part of the potential was interpreted by assuming that each nucleon in the nucleus interacts separately with a cross section σ_f. This cross section represents an average cross section for the protons and neutrons and is given by

$$\sigma_f = \frac{Z\sigma_{pf} + (A-Z)\sigma_{nf}}{A} \qquad (1)$$

where σ_{pf} is the free K^+ - proton cross section and σ_{nf} is the free K^+ - neutron cross section.

After due account was taken for the effect of the Pauli exclusion principle,[3] it was found that σ_f decreased in the heavier elements much faster than could be explained by the neutron excess.

We have now extended the measurements to pure hydrogen and have reanalyzed the old data in terms of a more realistic nuclear-density distribution.

HYDROGEN CROSS SECTION

The experimental arrangement for the hydrogen measurement was the same as for the experiment with complex nuclei and has been described elsewhere.[1] The geometry of the attenuation counters was arranged such that any K^+ scatter greater than 27° and less than 165° in the center-of-mass frame was detected. The targets used were carbon and polyethylene and the hydrogen cross-section result was obtained from the difference. The cross section for the angular interval given above and a K^+ energy of 190 Mev is 14.3 ± 2.8 mb. If we assume a uniform angular distribution, the total K^+ proton scattering cross section becomes 15.4 ± 3 mb.

COMPLEX NUCLEI

The data for the complex nuclei has been reanalyzed using the nucleon density distribution similar to that of the nuclear charge distribution given by Hahn et al.[4] This distribution is given by

$$\begin{aligned} \rho(r) &= \rho_0 & r &\leq r_1 \\ &= \rho_0 \frac{(r - r_1)}{(r_2 - r_1)} & r_1 &\leq r \leq r_2 \qquad (2) \\ &= 0 & r_2 &\leq r \end{aligned}$$

where $1/2\,(r_1 + r_2) = 1.07 \times A^{1/3}$ Fermis, and $(r_1 - r_2) = 3.0$ Fermis. Using Eq. (2) and the optical approach we calculated σ_f from the measured cross section for each of the nuclei. In each case, the Pauli exclusion principle was accounted for as described by Sternheimer.[3] The values of σ_f are given in Fig. 1.

K-NEUTRON CROSS SECTION

If one uses the value of the K-proton cross section given above, the value of σ_f can be calculated from Eq. 1 for various values of σ_{nf}. A value of $\sigma_{nf} = 7.5 \pm 2.1$ mb gives the best fit to the data. σ_f calculated using this value is plotted in Fig. 1.

DISCUSSION

If one assumes the K^+ scattering process to conserve isotopic spin, the above values for σ_{nf} and σ_{pf} can be used to calculate the relative importance of the T = 1 and T = 0 states in the K^+ - neutron process (K^+ - proton interaction is all in the T = 1 state). The data then are consistent with σ_{pf} 2 σ_{nf} which indicates that the contribution from the T = 0 state is small. In the absence of a contribution from the T = 0 state, one expects the charge-exchange cross section for K^+ mesons on neutrons to be approximately one-half of the total K—neutron cross section, or about 3.7 mb, which is quite consistent with the values found in experiments with nuclear emulsions.[5]

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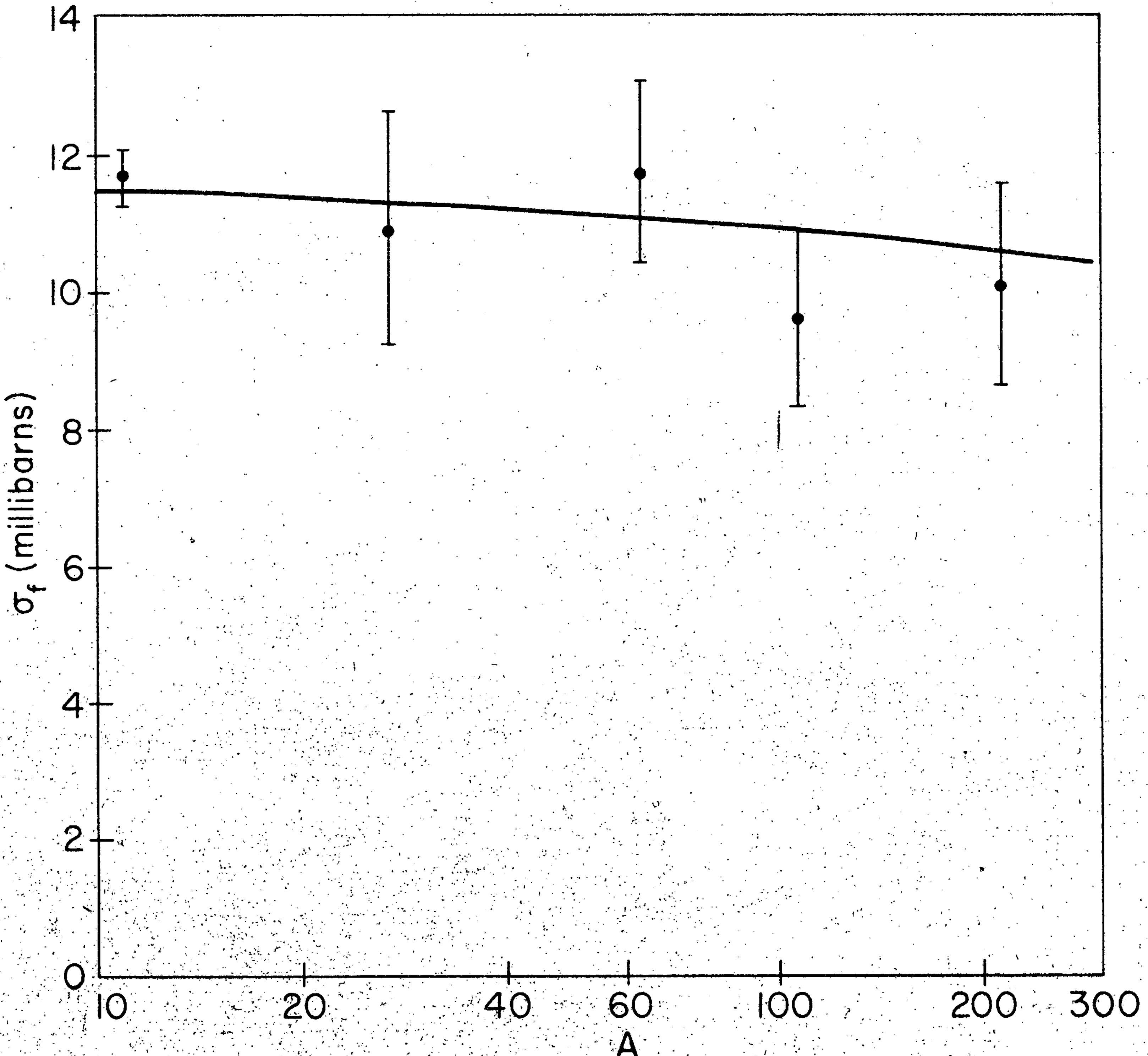
REFERENCES

1. Leroy T. Kerth, The Total Cross Sections for 190-Mev Positively Charged K Mesons in Complex Nuclei, UCRL-3747, April, 1957.
   Kerth, Kycia, and van Rossum, Bull. Am. Phys. Soc., Ser II, 2, 222 (1957).
   Kerth, Kycia, and van Rossum, (To be published).
2. Fernbach, Serber, and B. Taylor, Phys. Rev. 75, 1352 (1949).
3. R. M. Sternheimer, Phys. Rev. 106, 1027 (1957).
4. Hahn, Ravenhall, and Hofstader, Phys. Rev. 101, 1131 (1956).
5. Joseph E. Lannutti, UCRL (Private communication).
   B. S. Zorn and G. T. Zorn (To be published).

FIGURE LEGENDS

Fig. 1. The free cross sections σ_f determined from the ex perimental cross sections for K^+ mesons on various nuclei. The solid curve is calculated from Eq. (1) with σ_{pf} = 15.4 mb and σ_{nf} = 7.5 mb.



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