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CROSS SECTIONS FOR ELASTIC SCATTERING OF 195-Mev POSITIVE PIONS BY CARBON AND LITHIUM NUCLEI

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THE elastic-scattering cross sections were measured at the Joint Institute for Nuclear Research with the aid of the synchrocyclotron and the same cloud chamber in magnetic field as used in the experiments with negative particles.[1] The source of positive pions was a polythene block 25 g/cm^2 thick, placed in the external 670-Mev proton beam. Particles of specified momentum were guided to the chamber by a deflecting magnet and a four-meter collimator placed in the concrete shield of the accelerator. Carbon and lithium targets (natural mixtures of the isotopes of these elements), 1.72 and 0.8 g/cm^2 thick, respectively, were placed in the working volume of the chamber. The intensity of the magnetic field in which the chamber was placed was 13,500 oe.

The experimental procedure and the processing of the photographs were the same as in the experiment with the negative pions.[1] In particular, the criterion for distinguishing elastic from inelastic scattering was the minimum measured energy loss, equal to 35 Mev. Taking into account corrections for detection efficiency in the angle interval from 10 to 180°, we registered 410 and 243 events of elastic scattering of mesons by carbon and lithium respectively.

The measured total cross sections (in millibarns) are listed in the table; to determine the absolute values of the total cross sections for elastic scattering, the total inelastic-scattering cross sections were normalized to the geometric nuclear cross sections for $R = 1.4 A^{1/3} \times 10^{-13}$ cm.

Nucleus	Energy, Mev	Pion sign	Elastic, 10°	πR^2
C	195	+	204±26	325
Li	195	+	156±26	226
C	230	—	200±31	325

The last row of the table contains the total cross section for the elastic scattering of negative mesons by carbon.[1] Comparison of the data given for carbon nuclei shows that, within the limits of experimental error, the elastic-scattering sections are the same for positive and negative mesons with respective energies of 195 and 230 Mev. The cross sections obtained are also in satisfactory agreement with

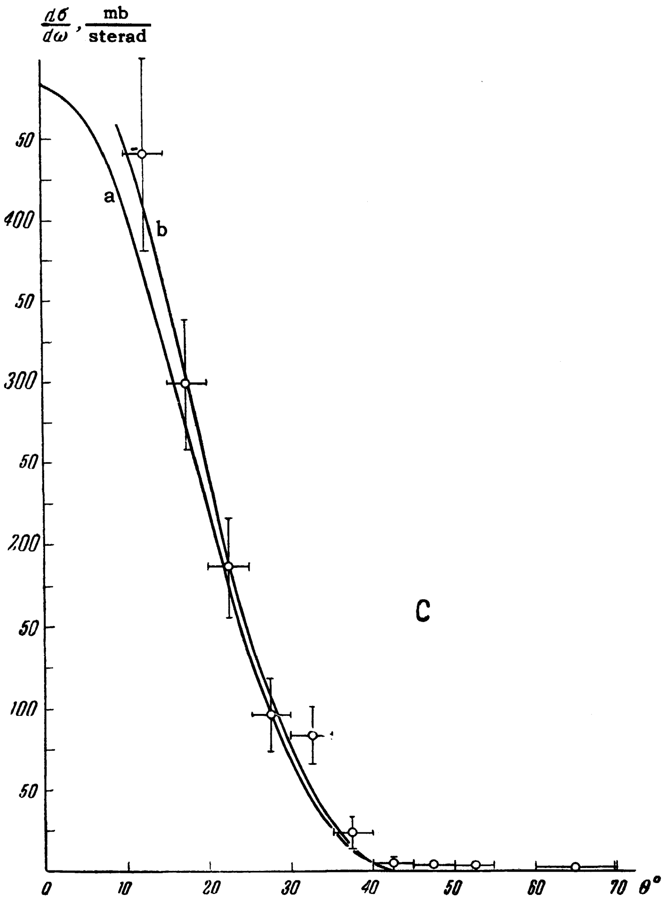

FIG. 1

the calculated values (equal to 0.6 to 0.8 of the geometric cross sections) obtained by Sternheimer[2] and by Osipenkov and Filippov[3] on the basis of the optical model, with an interaction potential in the form of a rectangular well of radius R. In these calculations, the parameters of the well (depth of well and coefficient of absorption of the pions in nuclear matter) were determined from the cross sections for the scattering of pions by free nucleons.

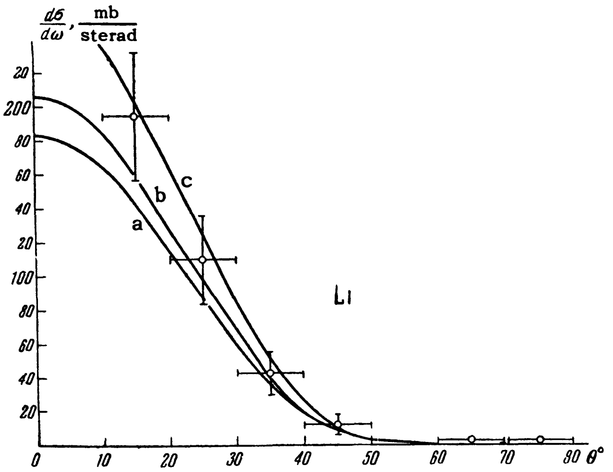

FIG. 2

The experimentally-obtained angular distribution of elastic scattering by carbon and lithium are illustrated in Figs. 1 and 2. The solid curves represent the angular distributions computed in the quasi-classical approximation from the optical-model equations* (for the range from 0° to the angle corresponding to the position of the first diffraction minimum) for the following values of the parameters: nuclear radius $R = 1.4 A^{1/3} \times 10^{-13}$ cm, coefficient of meson absorption in nuclear matter $K = 0.83 \times 10^{13}\ \mathrm{cm}^{-1}$ the real part of the potential V is equal to zero for curve A and 30 Mev for curve B; $K = \infty$ and $V = 0$ for curve C. As can be seen from the diagram, the measured distributions agree with the computed ones, but within the limits of experimental error no definite conclusions can be made regarding the magnitude or sign of the real part of the potential. It is obvious that the description of the measured angular distributions with the aid of a rectangular-well potential is inadequate, since these distributions (as shown in references 5 and 6) do not exhibit the clearly-pronounced minima and maxima which characterize such a potential. For example, it was found in references 5 and 7 that to obtain correspondence between the experimental and computed data over the entire range of distribution angles it is necessary to forego, in the computations with the optical model, the homogeneous distribution of the nucleons of the nucleus and to add to the interaction potential a term proportional to the gradient of the nuclear density. No right-left asymmetry of elastic scattering of positive pions was observed in the experiment for either nucleus.

*The computation formula is taken from the book of Akhiezer and Pomeranchuk.[4]

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ELECTROMAGNETIC MASS OF THE K MESON

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In the recent experiments by Rosenfeld et al.[1] and Crawford et al.[2] it was established that the mass of the neutral K meson exceeds that of the charged K^+ meson by ~4.8 Mev. On the face of it the sign of this mass difference appears to contradict the concept that the K^+ and K^0 mesons are spinless particles belonging to the same charge doublet. Indeed, if the K^0 meson has no electromagnetic interactions and the mass difference is of electromagnetic origin then the electromagnetic self-mass of the charged K meson should make it heavier than the neutral one (see, e.g., reference 3). On this basis the above-mentioned authors are inclined to interpret their results as an argument in favor of the Pais hypothesis,[4] according to which the K^+ and K^0 meson do not form a charge doublet and may have different intrinsic parities.