$2bK \gg 1$. In the other limiting case $ka \gg 1$ the high energy region), we obtain for σ

$$\sigma = \frac{4\pi}{k^2}\int_0^\infty \frac{2l\,dl}{1+\operatorname{ctg}^2\eta_l}$$

$$\approx 4\pi a^2 \begin{cases} {}^1/_6\Upsilon^2 & \text{for } {}^2/_3\Upsilon^{2}/_3 Ba\,K/c\hbar k \ll 1, \\ 1 & \text{for } {}^2/_3\Upsilon \gg 1. \end{cases}$$

Thus the cross section will be four times greater than its classical value. As has been shown by Massey and Mohr[8], the discrepancy between the classical and quantum values is associated with diffraction. Let us compare our results with those given by Mott and Massey[9] (p. 56) for an analogous problem using the smooth joining of wave functions:

$$\sigma = \begin{cases} 4\pi a^2 & \text{for } ka \ll 1, \\ 2\pi a^2 & \text{for } ka \gg 1, \end{cases}$$

i.e., the theories will agree exactly except for numerical coefficients when $ka \gg 1$.

For scattering from a δ-center we were recently able to compare damping theory and other theories. In the nonrelativistic case, the wave equation is (hk_0/c is the mass of a particle)

$$(\nabla^2 + k^2)\Psi = (2k_0/c\hbar)\,V_0\delta(\mathbf{r})\,\Psi.$$

The solution of this equation which satisfies the radiation condition for $r \to \infty$ is

$$\Psi = Ae^{ikz} + A'\left(\frac{1}{8\pi^3}\int \frac{\exp\{i\varkappa \mathbf{r}\}}{k^2-\varkappa^2}\,d^3\varkappa - \frac{i}{4\pi}\,\frac{\sin kr}{r}\right).$$

Keeping in mind the value of the integral

$$\frac{1}{8\pi^3}\int \frac{\exp\{i\varkappa\mathbf{r}\}}{k^2-\varkappa^2}\,d^3\varkappa = \begin{cases} -(1/4\pi r)\cos kr, & r>0, \\ -(\alpha/\pi^2) & , \ r=0, \end{cases}$$

where α defines the range in which the wave vector of the scattered particle changes $(k-\alpha \leqslant \varkappa \leqslant k+\alpha)$, we obtain for the cross section

$$\sigma = \frac{|A'|^2}{4\pi\,|A|^2}$$

$$= k_0^2V_0^2/\pi c^2\hbar^2\left[\left(1+\frac{2k_0V_0\alpha}{c\hbar\pi^2}\right)^2 + \frac{k_0^2k^2V_0^2}{4\pi^2c^2\hbar^2}\right]^{-1}$$

In solving the problem by perturbation theory, we had to drop terms depending on V_0 in the denominator of (6). In damping theory we had to set α equal to zero in the denominator of (6). This represents the fact that we shall take only resonance terms into account for the scattering ($K \sim K$). Finally, solution by joining of wave functions corresponds to $\alpha \to \infty$. In this case, on complete agreement with (5), we find that for a δ-function interaction scattering should not occur at all.

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*Particle scattering with account taken of damping has also been discussed in Ref. 6 (p. 212).

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Total Inelastic Interaction Cross Sections of 225 ± 10 mev Negative π-mesons with C, Al, Cu, Sn, and Pb nuclei

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IN experiments carried out with the synchrocyclotron of the Laboratory of Nuclear Problems we have determined total cross-sections for the inelastic interaction of π-mesons with nuclei of carbon, aluminum, copper, tin and lead.

For these measurements we used the method of recording the events which result in the removal of the particle from the beam in passing through a scatterer made of the substance under investigation. The mean angle into which the particle was removed was 30°. A telescope consisting of three scintillation counters was used as the meson recording apparatus. In the first and second counters, toluene crystals 30 × 30 × 5 mm in size were used as scintillators; a liquid scintillator (a solution of terphenyl in toluol) 100 mm in diameter was used for the third counter. The first two counters recorded π-mesons incident on the scatterer; the third counter recorded particles which had passed through the scatterer which was in the form of a disc 60 mm in diameter placed in the beam immediately after the second counter. In front of the third counter a lead filter of thickness 5.85 g/cm^2 was placed in order to absorb heavy charged particles formed as a result of the interaction of π-mesons with the nuclei of the scatterer. In order to determine the number of events resulting in the removal of π-mesons from the beam a simultaneous count of double and triple coincidences was made. The efficiency of the last counter was tested in a proton beam of 1 cm^2 cross-section; it turned out to be equal to 96% and practically did not depend on the place at which the particles struck the scintillator.

Element	Cross section in units of 10^{-27} cm^2	
	Measured	geometric*
C	346 ± 21	325
Al	596 ± 30	553
Cu	1058 ± 45	977
Sn	1550 ± 70	1480
Pb	2290 ± 90	2150

The energy of the π-mesons incident on the scatterer, and also the total content of μ-mesons and electrons in the beam were determined separately by measuring the absorption curve for π-mesons in copper using the same geometry as in the experiment being described. These measurements showed that the energy of π-mesons in the beam is equal to 230 ± 6 mev, while the content of μ-mesons and electrons in the beam amounts to 12.5 ± 3%. The scatterer thickness was on the average equal to 5–6 g/cm^2, so that the mean energy of the π-mesons to which the measured cross sections correspond was equal to 225 ± 10 mev.

Corrections were made to the measured cross sections using the data of reference 1 in which the Wilson cloud chamber was used to study the interaction of negative π-mesons with carbon and lead nuclei at an energy of 230–350 mev; these corrections took into account: a) inelastic scattering of π-mesons into the angular interval from 0 to 30°; b) elastic scattering of π-mesons into the angular interval from 30 to 180° and c) fast secondary protons recorded by the third counter. The total cross sections for the inelastic interaction of π-mesons with nuclei obtained by the method described above are given in the Table. It may be easily seen that at an energy of 225 mev these cross sections are equal to the geometric cross sections of the corresponding nuclei. Within the experimental error these results agree with the results of similar measurements carried out in reference 2 at π-meson energies of 216 and 250 mev.

*For the calculation of geometric cross sections the nuclear radius was taken equal to $R = 1.4\ A^{1/3}\ 10^{-13}$ cm.

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Nuclear Interactions with 220-mev Deuterons

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IT is characteristic of the interactions between high-energy deuterons and nuclei that fast protons are emitted. At least three processes exist by which fast protons can be produced in inelastic collisions of high-energy deuterons. As has been shown by Serber[1] and confirmed experimentally by Chupp, Gardner and Taylor[2], when a target is bombarded by fast deuterons there occurs a process wherein a deuteron is split on a nucleus with the neutron being captured by the nucleus and the proton proceeding past with energy which is about half of the deuteron energy. The cross section for this "stripping" process is quite high and is only slightly dependent on the atomic number, varying from 0.1×10^{-24} cm^2 for Be to 0.3×10^{-24} cm for U. Another source of fast protons when various nuclei are bombarded by deuterons is the deuteron disintegration caused by the Coulomb field of the nucleus[3]. This process has a small cross section and is comparable with the cross section for "stripping" only in the case