of the non-ionized gas has been plotted on the same graph, as a dotted line.

The dependence of the specific heat on the temperature at higher temperatures will have the same character.

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Elastic (p–p)–Scattering and Peculiarities of Interaction between Pions and Nucleons

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STRONG interaction between a pion and a nucleon, which exerts a significant effect on the process of pion production in the collision of a nucleon with a nucleon, may develop also in the process of the elastic (p–p)–scattering. Two mechanisms are possible. One of these can be schematically expressed in the form

$$p + p \to (\pi + N + p)^* \to p' + p' \tag{1}$$

and it corresponds to the process of resonance scattering. The second is inevitably produced as a result of the known optical relationship between elastic and inelastic processes. In so far as the values of the elastic and inelastic cross sections owing to this relationship are of the same order, and the cross section of the inelastic processes

$$N + N \to \pi + N + N' \tag{2}$$

is comparatively large at energies beginning with 499 mev, therefore the role of the second factor may be considerable.

The calculation of the probability of the elastic (p–p)–scattering taking into account the virtual mechanism (1), carried out by Austern[1], gives values for the differential cross section differing by two orders from the values observed in experiment. This permits us to draw the initial conclusion that the peculiarities in the elastic (p–p)–scattering, apparently, are completely dependent on the second mechanism.

A juxtaposition of the elastic (p–p)–scattering with the processes of interaction between a pion and a nucleon can be made when these processes are compared at equal values of total energy in a center-of-mass system of the colliding particles. Moreover, it is also necessary to take into account the energy corresponding to the rest mass of the pion. For the value characterizing the probability of scattering at a given angle, it is necessary to consider the derivative

$$k^2\, d\sigma(\theta) / d\omega = \alpha(\theta), \tag{3}$$

where k is the wave vector of the colliding particles in a center-of-mass system, and $d\sigma/d\omega$ is the differential cross section of scattering at the angle θ in a c. m. system.

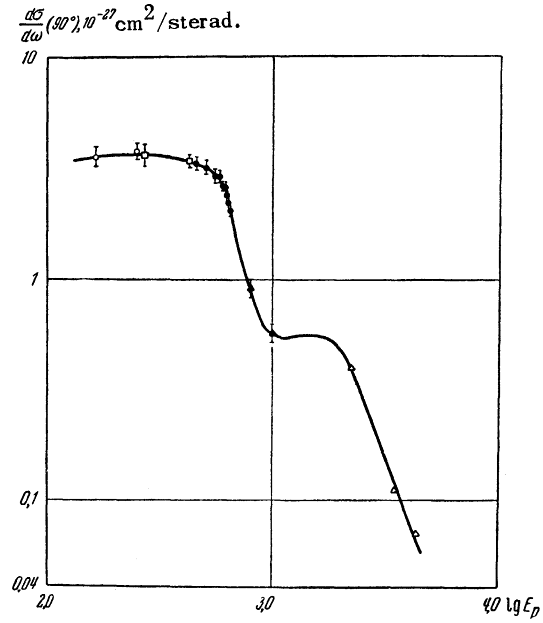

FIG. 1. The energy dependence of the elastic (p–p)–scattering at the angle 90°. □ –according to Ref. 2, O–according to Ref. 3, ●–according to Ref. 4, ▲–according to Ref. 5, Δ–according to Ref. 6.

Figure 1 gives the results of measurements of the differential cross section of the elastic (p–p)–scattering at the angle of 90° in the energy region from 160 mev to 4.4 bev taken from the investigations.[2-6] Figure 2 gives the dependence of the value $\alpha(90°)$ on the energy of the incident proton taken from the data of the above-mentioned investigations. As is evident from this figure, the latter curve (90°) has a maximum at total energy in a c. m. system at approximately 280 mev. It is precisely at these values of total energy in a c. m. system that the known peculiarities of the process $p + p \to \pi^+ + d$ are observed, as well as of the simpler processes $\gamma + p \to \pi^+ + p$ and $\pi^+ + p \to \pi^+ + p$. The appearance of this maximum is generally associated with the peculiarities of the interaction between a pion and a nucleon in states with an isotopic spin of $T = 3/2$.

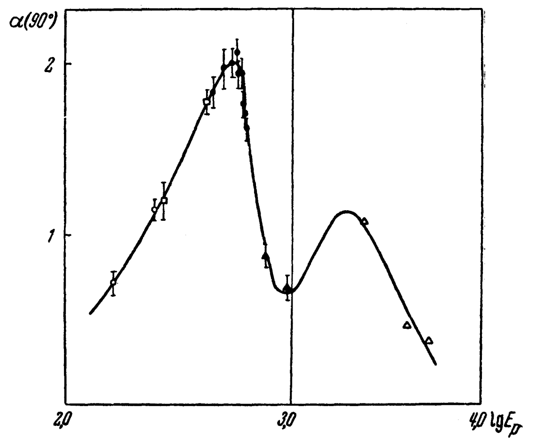

FIG. 2. The energy dependence of α (90°) for the states with the isotopic spin $T = 1\frac{1}{2}$. □ —according to Ref. 2, O—according to Ref .3, ●—according to Ref. 4, ▲—according to Ref. 5, Δ—according to Ref. 6.

In addition to this latter peculiarity, at present a maximum is also known for the states of a pion and and a nucleon with an isotopic spin of $T = 1/2$, which is observed at the pion energy of ~ 800 mev in a laboratory system of coordinates, or at a total energy of ~ 600 mev in a center-of-mass system. The hypotheses of Dyson[7] and of Brueckner[8] clarify the causes of the appearance of this second maximum, however its nature has not yet been established, If this second maximum appears as a result of a strong interaction between a pion and a nucleon, then one would expect to find peculiarities in the interaction between two protons in the same energy region. Initial data on the value α (90°) at energies higher than one bev indicate the presence of this predicted peculiarity, namely: as is evident from Fig. 2, in the energy region (1.5 – 2) bev the value α (90°) undergoes non-monotonic change. The total energy in a center-of-mass system corresponding to this region is equal to 600–700 mev.

The states of a two nucleon system with $T= 0$ cannot experience the effect of strong interaction between a pion and a nucleon in the state s with $T = 3/2$, since $T_{\pi N} = 3/2$ and $T_N = 1/2$ can produce only the states with $T = 2$ and $T = 1$. Therefore, the dependence curves of α (90°) for the states of two nucleons with $T = 0$ should not possess any of the peculiarities which can be observed for $T = 1$. Although the experimental data substantiate this prediction, they do not permit us to draw such a conclusion with complete certainty.

The maximum of the dependence of the total cross section of the interaction between a pion and a nucleon in the states with $t = 1/2$ at total energy in a center-of-mass system of ~ 600 mev should appear in the processes of the elastic scattering of a nucleon on a nucleon in the states with $T = 1$ and $T = 0$. This permits us to draw the conclusion that the dependence curve of α (90°) for the states of two nucleons with $T = 0$, beginning with the energy (0.8–1.0) bev, should reproduce almost completely the corresponding curve for the states of two nucleons with $T= 1$.

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Interaction between Negative Pions and Helium Nuclei at 330 mev Energy

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AT present there exist few investigations devoted to the interaction between pions and nuclei at energies higher than 200 mev. In particular, very little data have been obtained on the interaction between pions and the simplest nuclei. Below we will describe the results of the study of the interaction between negative pion and helium nuclei at 330 mev energy.

For the observation of simple interactions we have used a diffusion chamber of 270 mm in diameter which was filled with helium at a pressure of