ment is the influence of geological conditions (electrical conductivity), which as geophysical experience has shown can alter the amplitude of a magnetic disturbance at a recording station by several magnitudes.

The enhancement of the measured magnetic disturbance over the maximum amplitude predicted by the magnetostatic model forces one to seek a different concept of the propagation of the disturbance. Ya. A. Al'pert has suggested that a disturbance propagates in the space between two conductive layers, i.e., the ionosphere and earth. The disturbance therefore is only slightly weakened with distance. It travels from the explosion point to this spherical layer in the form of a magnetohydrodynamic wave in the ionosphere and is propagated along magnetic field lines with slight absorption.

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## *THE $d + d \to \pi^0 + He^4$ REACTION AT 400 Mev DEUTERON ENERGY*

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UP till now all experimental investigations in testing the principle of charge invariance in the formation process of $\pi$ mesons were carried out by comparing two charges of coupled reactions, the cross sections of which have to be in a given relation while preserving the full isotopic spin. This refers to the reactions $p + p \to d + \pi^+$ and $n + p \to d + \pi^0$, which were investigated at 400 and 600 Mev, and also to the reactions $p + d \to t + \pi^+$ and $p + d \to He^3 + \pi^0$, which were compared at 340,[5] 450,[6] and 600 Mev.[7]

However, a more direct method of checking the principle of charge invariance, which is free from any systematic errors, consists of establishing the degree of forbidenness as a consequence of the preservation of the isotopic spin in the process of meson formation. Thus, for instance, forbidenness due to this principle should take place in the reaction[8]

$$d + d \to \pi^0 + He^4. \quad (1)$$

By this process it is also possible to check the hypothesis, advanced by Baldin,[9] of the existence of the isotopically scalar $\pi^0$ mesons, to eliminate the contradiction between the data covering the photoproduction of $\pi$ mesons near threshold and the Panofsky relation.

A description follows here of the first data of the reaction (1), obtained in the synchrocyclotron of the Joint Institute for Nuclear Research at 400 Mev deuteron energy. The measurements were made with an extracted beam of deuterons having an intensity of about $3 \times 10^{10}$ sec$^{-1}$. The secondary charged particles formed in the targets of heavy polyethylene and carbon were separated by a brass collimator placed at an angle of 5.6° to the deuteron beam, were deflected by a magnetic field at an angle of 27°, and passed through a steel collimator in the shielding concrete wall. They were then recorded by a telescope consisting of six scintillator counters. The identification of the charged particles knocked out of the target was carried out by effective momentum, specific ionization, and range. The separation of particles with a given momentum was carried out with the aid of an electromagnet, the poles of which had been given a special shape to improve resolving power. The separation of the particles with regard to the extent of the specific ionization was made independently in each of the five telescope counters. This method[10] made it possible to separate reliably the rare processes of the emission of particles with a high degree of ionization against the background of the extraneous radiation of lower ionization. The particle range was determined by retarding filters, which were arranged before the fifth and the sixth telescope counter, the latter being connected in anticoincidence with the first five so as to separate the particles in the given range interval. In the first five telescope counters scintillators were used with foils 0.5 mm thick, which enabled the recording of the $\alpha$ particles starting with 60 Mev energy. The discriminator scale was calibrated in a beam of $\alpha$ particles at 800, 700, 460, and 370 Mev. The general control of the apparatus and the calibration of the electromagnet scale were carried out by recording the $He^3$

nuclei originating from the reaction $d + d \rightarrow He^3 + n$.

The $\alpha$-particle yield from heavy polyethylene and carbon with an effective momentum 635 Mev/c, corresponding to the $\alpha$ particles of reaction (1), was measured under an angle of 5.6° in the laboratory system, to which an isotropic angle $[\theta = a \times \cos^{-1}(1/\sqrt{3})]$ corresponds approximately in the c.m.s. The absolute cross sections were determined under the same conditions, by recording the deuterons from the reaction $p + p \rightarrow d + \pi^0$, the cross section of which is well known[11] at present. The results of the first measurements have shown that, with a reliability of 90%, the total cross section of reaction (1) is

$$\sigma_t(d + d \rightarrow \pi^0 + He^4) < 1 \cdot 10^{-31} \text{ cm}^2$$

The estimate obtained proves that the cross section of reaction (1) surpasses only a few times the cross section of the electromagnetic process $d + d \rightarrow \gamma + He^4$, which according to the data of the reverse reaction[12] $\gamma + He^4 \rightarrow d + d$ amounts to about $10^{-32}$, whereas in the absence of forbiddenness in reaction (1) the cross sections of these two processes may differ by a factor of $10^2$.

Since, under the conditions of the given experiments, the $\alpha$ particles resulting from the reaction $d + d \rightarrow \pi_0^0 + He^4$, in which the formation of the isotopically scalar $\pi^0$-meson takes place may also be recorded, the estimate of the total cross section received for reaction (1) may be looked upon as an indication that isotopically scalar $\pi^0$ mesons are not present in large quantities in the $(135^{+15}_{-35})$ Mev interval.

We also measured the differential cross section of the reaction $d + d \rightarrow He^3 + n$ for the angle 5.6° in the laboratory system, and found it to be equal, in the center-of-mass system, to

$$\frac{d\sigma}{d\Omega}(15.5^\circ) = (3.8 \pm 0.5) \cdot 10^{-29} \text{ cm}^2/\text{sr}.$$


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## *ON THE PROBLEM OF PERIPHERAL COLLISIONS OF NUCLEONS WITH HIGH ENERGIES*

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TAMM[1] has recently developed a model for the interaction of fast nucleons with large impact parameters, according to which the interaction is due to the exchange of one $\pi$ meson, whereby one or both nucleons are excited to an isobaric state which subsequently decays.

Together with the excitation of the isobar $(\frac{3}{2}, \frac{3}{2})$ (which we shall denote by the symbol X in the following), an interaction with the isotopic spin $\frac{1}{2}$ is also possible. The latter can be interpreted as the excitation of the second isobaric level of the nucleon.[2] This second isobar (which we denote by the symbol Y) can decay according to the following schemes:

$$\begin{aligned} &1)\ Y \rightarrow N + \pi, && \omega_1 = 0{,}324; \\ &2)\ Y \rightarrow X + \pi, && \omega_2 = 0{,}418; \\ &3)\ Y \rightarrow N + 2\pi, && \omega_3 = 1 - \omega_1 - \omega_2 = 0{,}258. \end{aligned}$$

The probabilities, $\omega$, for these decays can be estimated by the statistical weights, assigning to the isobar Y the mass $1.64\,M_{nucl}$, the isotopic spin $\frac{1}{2}$, and linear dimensions of the order $\hbar/\mu c$. We