$$K^+ + p \rightarrow D^+ + \Sigma^+, \qquad D^+ \begin{array}{l} \nearrow K^0 + \pi^+ \\ \searrow K^+ + \pi^0 \end{array}$$

Here, the first (more probable) branch of the decay should have a very characteristic appearance (a V-event aiming at the kink in the D^+-meson track).

Events resembling the D^+-meson production and decay were measured on a semi-automatic arrangement, whose output was punched on tape. The spatial reconstruction of the picture and the kinematic analysis were made on an electronic computer with a special program. The method of data reduction was tested on pp elastic scattering and several cases of associated production of a K^+ meson and a Σ^+ hyperon on free protons:

$$\pi^+ + p \rightarrow K^+ + \Sigma^+. \qquad (3)$$

The cases of pp elastic scattering and reaction (3) were identified by means of kinematic curves. The number of recorded cases of associated production of a K^+ and a Σ^+ hyperon corresponded to the fraction of π^+ in the beam and to the cross section for reaction (3).

This analysis did not disclose any cases of D^+-meson production. We can thus estimate the upper limit for the D^+-meson production cross section in reaction 2:

$$\sigma < 2 \cdot 10^{-29}\ \text{cm}^2.$$

A similar conclusion ($\sigma < 3 \times 10^{-29}$ cm^2) can be made for the reaction

$$K^+ + n \rightarrow D^+ + \Sigma^0, \qquad (4)$$

which was also not found in the scanning. Hence the D^+-meson production cross section in the interactions between K^+ mesons and nucleons is

$$\sigma < 1.2 \times 10^{-29}\ \text{cm}^2.$$

It should be noted, that, for the assumed mass of the D^+ meson (≈ 720 MeV), reaction (2) and (4) should be occurring far above threshold.

In conclusion, the authors consider it their pleasant duty to thank V. I. Veksler, I. I. Gurevich, and I. V. Chuvilo for their constant interest in and attention to this work, and also the proton-synchrotron crew for ensuring the proper operation of the accelerator. We are pleased to thank V. I. Baranov L. S. Baturin, A. P. Venediktov, A. A. Kondrashin, A. V. Tel'nov, S. Kh. Khakimov, V. K. Makar'in, V. P. Martem'yanov, A. F. Burtsev, A. I. Maleev, B. V. Sokolov, I. V. Panov, N. S. Moroz, and Z. D. Dobrokhotov for aid in the measurements and reduction of the data.

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DEPOLARIZATION OF THE POSITIVE MUON IN AN ELECTRIC FIELD

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In the present paper we consider the influence of a strong electric field ($E \sim 10^5$ V/cm) on the depolarization of the positive muons produced by $\pi \rightarrow \mu$ decay in emulsion. It can now be regarded as proved that the depolarization of the stopped positive muon is essentially due to the formation of muonium (the μ^+e^- system). This deduction follows from experiments on the dependence of positive-muon depolarization on the magnitude of the longitudinal magnetic field[1] (along the direction of the muon spin), and also from several other investigations[2,3] in which it is indicated directly or indirectly that muonium is produced upon deceleration of positive muons.

At the same time, experiments on the precession of the positive muon spin in a transverse magnetic field[4] have shown that the "stopped" positive muon precesses with a frequency corresponding to the free muon, and that, within the limits of experimental accuracy, it experiences no further depolarization.1) It follows therefore that muonium is produced only within a sufficiently short time, comparable with the time of ionization deceleration to "thermal" velocities. This experimental result is confirmed by quantitative calculations made by Nosov and Yakovleva[5]. So far, however, there are no experimental data to indicate whether the positive muon decays in condensed media while it is "free," or whether it is captured in a molecule prior to decay. A theoretical analysis of this question[6] has led to the conclusion that in hydrogen-containing substances (such as gelatin in emulsion) the positive muon is captured in a molecule within a time lapse exceeding $\sim 10^{-11}$ sec following the $\pi^+ \rightarrow \mu^+$ decay. In the present investigation we have obtained experimental indications that a positive muon stopped in emulsion is actually captured in the gelatin molecule. This conclusion follows from the observation of the additional depolarization of the positive muon in the presence of an electric field with intensity $E \sim 10^5$ V/cm, inasmuch as theoretical estimates show that such fields cannot depolarize the muon in the free state or in the muonium state.

The experiment was carried out in the following manner. Voltage pulses of amplitude $U = 5$ kV were applied to flat electrodes, between which emulsions 400 and 200 μ thick were placed. The corresponding electric field intensity in the emulsion was 1.2×10^5 and 2.4×10^5 V/cm, respectively. The voltage pulses, up to 600 μsec in duration and "rectangular" in form, were synchronized with a pulsed 85-MeV positive pion beam extracted from the synchrocyclotron of the Joint Institute for Nuclear Research. The duration of the positive pion pulse was 500 microseconds. All the π—μ—e decays in the emulsion occurred therefore when the emulsion was in the electric field of the indicated intensity. The time variation of the field during one voltage pulse did not exceed 10%. The pulsed electric field was used in order to avoid electric breakdown of the emulsion. To reduce the breakdown probability, we used, furthermore, NIKFI-R emulsions with a high gelatin content. Electrodes with emulsion layers placed between them were located in a special chamber, to which air under 10 atm pressure was fed during the time of the exposure to prevent formation of surface fog on the emulsion.

The emulsion chamber was screened against external magnetic fields. To determine the depolarizing ability of the emulsions used in this experiment, emulsion films of the same batch and under the same conditions were irradiated without a field, along with the emulsions irradiated in the field. This control experiment made it possible to eliminate also the effect of external magnetic field in the course of the determination of the influence of the electric field on the muon depolarization.

The emulsions irradiated in fields $E = 1.2 \times 10^5$ V/cm and $E = 2.4 \times 10^5$ V/cm were made from different batches; the control measurements of the asymmetry of the $\mu \rightarrow e$ decay electrons at $E = 0$ were therefore carried out separately for each case. The table lists the corresponding values of the asymmetry coefficient a, which determines the angular distribution of the $\pi \rightarrow \mu \rightarrow e$ decay electrons:

$$dN / d\theta \sim 1 - a \cos \theta.$$

As can be seen from the table, the value of a at $E = 0$ exceeds the value of a at $E \sim 10^5$ V/cm, thus evidencing the presence of additional depolarization of the positive muons in the presence of the electric field. As indicated above, this effect can be explained qualitatively if it is assumed that the stopped muon is captured in a molecule.

Values of the asymmetry coefficient a in irradiated emulsions in electric fields of different intensity

Irradiation	I		II		III [8]
E, V/cm	0	$1{,}2 \cdot 10^5$	0	$2{,}4 \cdot 10^5$	0
a	0,12±0,03	0,08±0,02	0,16±0,03	0,06±0,03	0,13±0,02

It must be noted that in principle such an experiment also affords an estimate of the electric dipole moment d of the positive muon. However, to determine d as accurately as was done by Charpak[7] it is necessary to produce in the emulsion a field $E \sim 10^6$ V/cm (under the condition that approximately 40,000 $\pi \rightarrow \mu \rightarrow e$ decays are observed).

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1)The latter conclusion is not absolute; when positive muons are stopped in B_4C, the muon becomes depolarized approximately 10^{-6} sec after stopping.

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ON THE CHARACTER OF πN AND pp SCATTERING IN THE REGION OF HIGH MOMENTUM TRANSFERS

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THE first qualitative conclusions on the character of the dependence of the elastic scattering differential cross section on the energy in the region of high momentum transfers were reported in [1], in which elastic scattering of 2.8-BeV/c π^- mesons on nucleons was investigated. From the analysis of πN and pp scattering in that work, it was shown that the probability for a momentum transfer of > 1 BeV/c in elastic scattering decreases as the energy of the incident particle is increased. A similar conclusion was also reached by other workers. [2,3]

In several recent theoretical studies, [4-6] predictions have been made on the asymptotic behavior of the elastic scattering amplitude for strongly interacting particles in the high energy region. According to the results obtained, the elastic scattering differential cross section should be described by an expression of the form

$$d\sigma_{el} / dt = f(t)\, s^{2[l(t)-1]}, \qquad (1)$$

where t is the square of the 4-momentum transfer in the scattering, and s is the square of the c.m.s. total energy of the scattered particles.

For any pair of strongly interacting particles, the function $l(t)$ should be the same. For $t = 0$, the value of $l(0)$ takes on its highest value, equal to unity if σ_t = const. A basic feature of formula (1) is the strong dependence of the cross section $d\sigma_{el}/dt$ on s in the region of high momentum transfers t. The dependence is of such a nature that the probability for a given momentum transfer should decrease with increasing s (we note that in the case of diffraction scattering $d\sigma_{el}/dt$ is a function of only the momentum transfer t).

Since the theoretically predicted dependence of the differential cross section on the energy is in qualitative agreement with the experimental data, it is of interest to estimate numerically the value of $l(t)$ for various strongly interacting particles on the basis of the available experimental data.

The above-mentioned experiments, as well as all others with which we will be dealing, were carried out in the 2—20 BeV range. The question arises as to the applicability of the asymptotic formula (1) in this energy range. It can be hoped that the accuracy of the results obtained with it will be the same as in the case of the well-known theorem of Pomeranchuk, [7] derived under similar assumptions.

The experimental data on πN scattering available at the present time [1,8-11] are shown in Fig. 1.

Despite the large amount of work, the statistical accuracy of most of the experiments and the range of values of s and t are not sufficient to determine the function $l(t)$ on the basis of these data. It should also be noted that, in each of the experi-

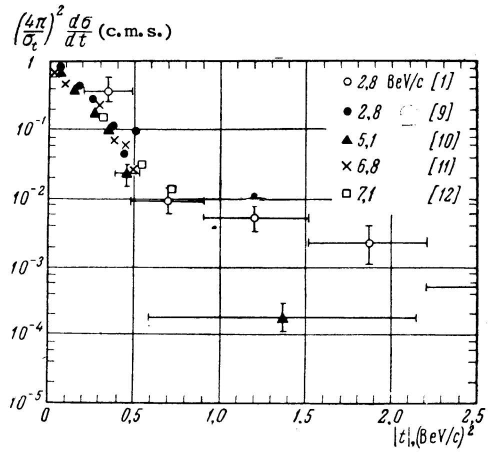

FIG. 1. C.m.s. differential cross section for πN elastic scattering plotted as a function of the momentum transfer t. The total cross section σ_t has been taken equal to 27 mb.