sults that the dependence of the polarization of (D + D) neutrons on the neutron energy is monotonic up to $E_d = 1.8$ mev. This monotonic property and the good accuracy of the values of P_{max}, as determined by us, make the (D + D) reaction a convenient source of neutrons with a colibrated polarization.

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* Editor's note: That's what it says!

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Altitude Dependence of Broad Atmospheric Showers According to the Various Models of the Elementary Act of Nuclear Collisions

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CALCULATIONS of the development in the atmosphere of nuclear-active and electron-photon components of broad atmospheric showers from primary protons of three different energies (10^{14}, 10^{16}, 10^{18} ev) were carried out for two variants of nuclear collision models. In both variants, the free path in air of the nucleons and pions was taken to be independent of the energy, and equal to 65 gm/cm^3, which corresponds to the geometric cross section of the nuclei of the atoms of the air.

In the first variant, it was assumed that for energies of the nucleons and pions higher than 5×10^{12} ev, creation of particles in nuclear collisions is described by the theory of Landau[1]. The energy spectrum and the composition of the secondary particles were assumed to be independent of whether a nucleon or a pion collided with the nucleus, and were taken from Ref. 2. The energy taken off by the secondary π-mesons was taken to be equal to 10% of the energy of the generating particle. The decay of the nuclear-active particles in the energy range $E > 5 \times 10^{12}$ ev could be neglected. In the energy region $E' < 5 \times 10^{12}$ ev, it was assumed that, independently of the nature of the generating particle of the energy E', in a collision of it with a nucleus, there is a nucleon among the secondary particles with energy $E = 0.7\,E'$, while the remaining energy $0.3\,E'$ is distributed among the created π^{+-0} mesons, the number of which is

$$n(E') = 2\,(AE'/2Mc^2)^{1/4},$$

where A is the average atomic weight of the nuclei of the air atoms, Mc^2 is the rest energy of the nucleon.

In the second variant of the calculations, in agreement with the assumption of Vernov,[3] it was taken into account that a nucleon of any energy (even for $E > 5 \times 10^{12}$ ev) loses only 30% of its energy in the formation of mesons in nuclear collisions, retaining 70%. It was further assumed that in the the collision acts only π^{+-0} mesons are produced, the multiplicity of which $n(E')$ was computed by Eq. (1), where the meson spectrum produced in the act is mono-energetic.

The development of the showers of nuclear-active particles in both variants was considered by the method of successive generation[4], with account taken of the decay of π^{+-0} mesons. The summation of the electron-photon showers arising from π^0-mesons was carried out graphically.

The results of the computations are shown in the Table where, in each column there is given the numbers obtained from the two variants (the upper is the first, the lower, the second). In the first column, we give the ratio of the energy flux $(EN_n)_p/(EN_n)_M$ carried by the nuclear-active particles for a high mountain (Pamir) to that for sea level (Moscow). The results of the calculations of the number of electrons at the altitude of Pamir N_{eP} and Moscow N_{eM} are given in the second and third columns, while the ratios of these numbers are given in the fourth. In the fifth and sixth columns, we have the computed and experimental values of the altitude dependence C_P/C_M between levels of Pamir and Moscow of the number of showers registered by usual method with the counters of corresponding area. As is evident from the Table, the experimental data on the altitude dependence of the number of showers from particles of energy $E \approx 10^{14}$-10^{16} ev agree better with the assumption on the loss of the nucleon in the nuclear collisions of only 30% of its energy. We have no experimental data on the altitude dependence of the number of showers from

TABLE

E_0	Computed values					Experimental values
	$(EN_\pi)_p/(EN_\pi)_M$	N_{ep}	N_{eM}	N_{ep}/N_{eM}	$\frac{C_p}{C_M}=\left(\frac{N_{ep}}{N_{eM}}\right)^\varkappa$	
10^{14}eV	6,0	$3{,}8\cdot 10^4$	$4{,}5\cdot 10^3$	8,5	20 ($\varkappa = 1{,}4$)	≈13
	5,33	$2{,}5\cdot 10^4$	$4{,}2\cdot 10^3$	6,0	12,4 ($\varkappa = 1.4$)	
10^{16}eV	5,2	$6{,}7\cdot 10^6$	$9{,}6\cdot 10^5$	7,0	22 ($\varkappa = 1{,}6$)	≈15
	5,30	$4{,}5\cdot 10^6$	$9{,}0\cdot 10^5$	5,0	13.0 ($\varkappa = 1.6$)	
10^{18}eV	4,7	$9{,}2\cdot 10^8$	$2.1\cdot 10^8$	4,4	15 ($\varkappa = 1.8$) 20 ($\varkappa = 2.0$)	
	5,14	$6{,}2\cdot 10^8$	$1.8\cdot 10^8$	3,5	9.6 ($\varkappa = 1{,}8$) 12,2 ($\varkappa = 2{,}0$)	

particles with energies $E \approx 10^{18}$ ev, but the data on the magnitude of the barometric effect at sea level for showers from primary particles of the same energy[5] agree better with the calculations based on Landau's theory.

The results of the calculations of the altitude dependence depend slightly on the energy spectra of the created mesons, but are very sensitive to the amount of energy remaining with the nucleon; therefore the results present a weighty argument that in the region $E > 5 \times 10^{12}$ ev (at least, up to $E \approx 10^{14}$-10^{16} ev) the nucleon in collisions with nuclei of the atoms of the air loses, on the average, only about 1/3 of its energy. Conversely, for the region of very high energies ($E \approx 10^{18}$ ev), we conclude that a significant breaking down in the energy of the nucleon takes place in nuclear collisions.

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The Construction of a Phenomenological Scattering Matrix with Non-local Interaction

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In recent years, detailed studies have been made on the possibility of introducing relativistically invariant cut–off form factors in the Schrödinger equation or in the equation of motion described in the Heisenberg representation.[1–3] It was shown that in all cases, multi–time equations become non–integrable, while the conditions of macroscopic causality are violated[2–4]. However, we can attempt to introduce the form factors directly into the relativistically invariant equation for the S-matrix which was obtained earlier in the theory with local interaction. Wataghin and Rayski [5] suggested the construction of the S–matrix, juxtaposing to each angle of the Feynman diagram (which corresponds to the theory with local interaction) a form factor while each internal line of this diagram is a causal function D^c or Δ^c [5].

Analytically, this suggestion can be formulated by writing the S matrix in the form*:

$$S = \sum_{n=0}^{\infty} \frac{(ie)^n}{n!} \tag{1}$$

$$\times \int_{-\infty}^{+\infty} P\,\{\varphi^*(x_1)\,A(x_1')\,\varphi(x_1'')\ldots\varphi^*(x_n)\,A(x_n')\,\varphi(x_n'')\}$$

$$\times F(x_1 x_1' x_1'')\ldots F(x_n x_n' x_n'')\,d^4(x_1\ldots x_n'').$$