was $\ell = 10$ cm; $\ell = 20$ cm for events with $E_1 \geq 2.2$ GeV.

2) The bremsstrahlung of electrons in the field of atomic electrons was calculated in accord with the theory of Wheeler and Lamb [13].

PHASE SHIFT ANALYSIS OF NUCLEON NUCLEON SCATTERING AT 400 MeV

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A phase shift analysis at 400 MeV was carried out earlier [1] and yielded three sets of phase shifts of equal probability as gauged by the χ^2 criterion. The phase shift analysis was made at $\ell_{max} = 4$, i.e., starting with orbital angular momenta $\ell = 5$, and the scattering amplitude was taken in the one-meson approximation. It was assumed that meson production takes place only from initial P, D. and F states with isotopic spin equal to unity, and is characterized by the average absorption coefficient for the given state [2] 1).

Data on the triple-scattering polarization and parameters, used in the cited paper [1], were later refined and published by a group of foreign authors [3]. This has made it possible to carry out a more refined phase shift analysis, the results of which are presented below.

The use of more accurate data on the triple-scattering polarization and parameters has caused the first two solutions of [1] to merge, and the errors of the phase shifts have been slightly reduced. The two remaining ones are given in Table I. Both sets of phase shifts are characterized by the fact that an imaginary part is possessed only by the phase shift of the $^1D_2$ wave. The imaginary parts of the ^3P and ^3F phases are small and do not improve the description of the experimental material.

The experimental data employed are listed in Table II.

From the obtained sets of phase shifts we calculated the dependences of the experimental quantities on the scattering angle; these are given in the preprint [4]. It is seen from the results that to eliminate the ambiguity of the phase shift analysis at 400 MeV it is necessary to carry out at least one experiment on triple np scattering. The planning of such an experiment and the determination of the optimal angle at which the measurements must be made are described in the paper by Lehar et al. [5]. It turns out that under the existing conditions the most effective means of eliminating the aforementioned ambiguity is to measure the parameters D and A at c.m.s. angles 60 and 55° respectively.

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Table I

Phase shifts in degrees (parametrization of Stapp et al. [15])

	Set 1		Set 2	
	δ^0	$\pm\Delta\delta^0$	δ^0	$\pm\Delta\delta^0$
	Real parts of phase shifts			
f^2	0.078	0.009	0.091	0.009
$^1S_0$	-13.46	1.78	-12.27	1.65
$^3S_1$	3.42	3.68	29.02	6.17
$^3P_0$	-13.50	1.91	-15.13	1.99
$^1P_1$	-48.43	2.15	-37.48	8.00
$^3P_1$	-33.80	0.81	-33.30	0.83
$^3P_2$	18.20	0.50	18.30	0.53
ϵ_1	+ 4.79	2.97	-20.10	7.05
$^3D_1$	-29.66	2.74	20.97	3.54
$^1D_2$	12.81	0.52	12.93	0.48
$^3D_2$	12.44	2.96	1.66	4.18
$^3D_3$	- 1.79	1.59	7.02	2.17
ϵ_2	- 1.11	0.69	- 1.28	0.68
$^3F_2$	1.77	0.57	1.78	0.55
$^1F_3$	- 3.59	1.30	- 3.60	1.30
$^3F_3$	- 2.55	0.43	- 2.37	0.45
$^3F_4$	3.68	0.27	3.70	0.28
ϵ_3	7.70	0.88	3.16	1.59
$^3G_3$	- 0.66	1.77	- 4.38	2.52
$^1G_4$	2.21	0.28	2.27	0.29
$^3G_4$	- 3.90	0.88	- 5.27	1.31
$^3G_5$	- 2.81	2.18	- 3.32	2.13
	Imaginary parts of phase shifts			
$^1D_2$	3.69	0.94	3.41	0.93
χ^2	79.20		82.14	
$\chi^2/\overline{\chi^2}$	0.90		0.93	

Table II

Data used for the phase shift analysis

Quantity	E, MeV	Number of points	Reference
σ_{pp}	380, 437	34	[6]
P_{pp}	415, 430	14	[3,7]
D_{pp}	415, 430	8	[3,8]
R_{pp}	430	7	[3]
A_{pp}	430	7	[3]
A'_{pp}	430	7	[3]
C^{pp}_{nn}	380, 400	3	[9,10]
$C^{pp}_{m\ell}$	400	2	[10]
σ^{t}_{pp}	410	1	[11]
σ_{np}	400	19	[12]
P_{np}	350	9	[13]
σ^{t}_{np}	410	1	[14]

Notation: σ - differential cross sections, P - polarization, D, R, A - triple-scattering parameters, σ^{t} - total cross section

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1) This means that the imaginary parts of the phase shifts of the ^3P and ^3F waves are identical.

UPPER LIMIT OF THE SPECTRUM OF COSMIC RAYS

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Powerful isotropic thermal radiation of the Universe, having apparently a Planck distribution with temperature $T \approx 3°K$, has been observed in recent measurements [1,2]. The intensity of this radiation ($N \approx 550$ photons/cm^3, $kT \approx 2.5 \times 10^{-4}$ eV) is such that unique effects arise when cosmic rays of superhigh energy pass through it, specifically, cutoff of the cosmic-ray spectrum in the vicinity of 10^{20} eV.

At sufficiently high primary cosmic-ray proton energies $E_p \sim M_pc^2(m_\pi c^2/E_{ph,eff})$ [3], pion photoproduction processes occur when the protons interact with the photon gas, as a result of which the protons effectively lose energy ($\overline{\Delta E_p}/E_p \approx 20\%$) [4]. If the characteristic time for proton-phonon collision becomes sufficiently small compared with the lifetime of the cosmic rays with these energies in the Metagalaxy, as determined by other processes (for example, the expansion of the Universe), then effective cutoff of the cosmic-ray spectrum will take place. An exact analysis gives for the characteristic time of collision between a proton of energy $E_p \gg M_pc^2$ and a photon, at the photon-gas equilibrium temperature T,

$$\tau_{p\gamma} = \frac{2\pi^2c^2\hbar^3\gamma^2}{kT\varphi}\ \text{sec}, \quad \gamma = E_p/M_pc^2, \tag{1}$$

where

$$\varphi = \int_{E_{thr}\kappa m_\pi c^2}^{\infty} dE E\sigma_{p\gamma}(E) \sum_{n=1}^{\infty} \frac{1}{n} \exp(-nE/2\gamma kT)\left(1 + \frac{1}{n}\frac{2\gamma kT}{E}\right), \tag{2}$$

$\sigma(E)$ is the total cross section for the absorption of a photon of energy E by interaction with