In a quite recent paper [11] Harari and Horovitz conclude, on the basis of a theoretical and experimental analysis of the photoproduction and of the results of [2] for max A ($\max A \leq 0.5$) from ρ-production, that the VDM predictions for A should be violated when $|t| = \mu^2$ (μ is the pion mass). They predict for photoproduction $A \approx 1$ at $|t| = \mu^2$. However, as shown by us, $A = 1$ does not contradict the data on ρ-meson production.

We note that if we assume the ρ, B Regge-pole model for the ω-production, then the conclusion for max A remains unchanged when account is taken of the ω-meson contribution.

It must be borne in mind, of course, that relation (3) is satisfied in the models under consideration already at not too small $|t|$. However, with increasing laboratory energy, (3) is satisfied for ever decreasing $|t|$. In practice, expressions satisfying (3) are obtained for ρ_{ij} already at 3 GeV, starting with $|t| \approx \mu^2$.

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NEW POSSIBILITY OF EXPLAINING THE COMPLEX FORM OF THE ENERGY SPECTRUM OF ULTRAHIGH ENERGY PRIMARY COSMIC RAYS

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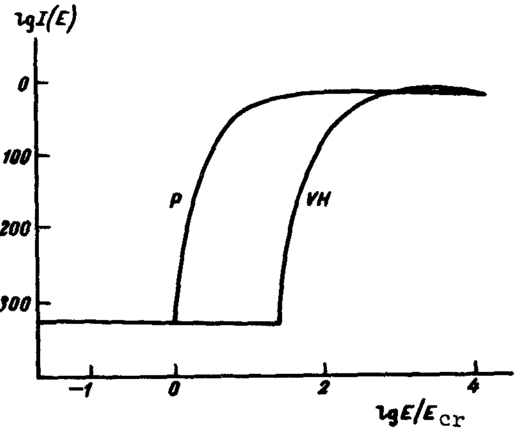
It can now be regarded as finally established that at energies $E \sim (2 - 4) \times 10^{15}$ eV the exponent of the energy spectrum of primary cosmic radiation increases from a value $\gamma = 1.6 - 1.7$ at $E < 10^{15}$ eV to a value $\gamma = 2.3 - 2.4$ at $E > 10^{16}$ eV [1 - 7]. Numerous experimental data indicate also that this exponent subsequently decreases back to $\gamma = 1.6 - 1.7$ at $E \gtrsim 10^{17} - 10^{18}$ eV [7 - 12]. Until recently, this result was considered in a natural fashion within the framework of the diffusion picture of cosmic-ray propagation in our galaxy, and the superposition of cosmic rays of galactic and metagalactic origin [7, 13, 14]. It became clear of late, however, that during the course of the interaction between the 3°K relict radiation and the cosmic rays the energy of the latter decreases, and a sharp cutoff of the energy spectrum sets in starting with an energy $\sim 3 \times 10^{19}$ eV [15, 16]; this apparently contradicts the available preliminary experimental data [17]. According to [18] there can exist in the universe also infrared radiation with temperature 8°K, leading to an earlier cutoff of the energy spectrum (at $\sim 10^{19}$ eV) and to a still greater discrepancy with experiment. It is therefore time to examine other possible models for the origin of ultrahigh-energy cosmic rays, such that the cosmic-ray propagation time from the source to the earth is much shorter than is obtained for cosmic rays of metagalactic origin.



Let us consider a model in which the cosmic ray are of purely galactic origin, and in which there exists, besides the stationary energy spectrum with integral exponent $\gamma = 1.7$, $\gamma = 1.7$, also a nonstationary component due to the explosion of the core of the galaxy and having near the source the same exponent of the integral energy spectrum, $\gamma = 1.7$[1]. Assuming that the diffusion coefficient is $D(E) = D_0 (E/E_{cr}z)^{\alpha}$ when $E > E_{cr}z$ and $D = D_0$ when $E < E_{cr}z$,[2] we have for the concentrations of the stationary and nonstationary components, respectively,

$$N_{st} = \frac{Q_{st}(E)}{4\pi D(E)r} \; ; N_{nons} = \frac{Q_{nons}(E)\, e^{-r^2/4D(E)t}}{(4\pi \cdot D(E)t)^{\frac{3}{2}\alpha}} \quad ; \qquad \alpha = 1 .$$

Here Q_{st} is the intensity of the stationary source, r is the distance from the galaxy center to the observer, Q_{nonst} is the number of particles of energy (E, E + dE) emitted by the nonstationary source, and t is the time elapsed from the instant of the explosion. Assuming $t = 10^6$ years $= 3 \times 10^{13}$ sec, $r = 3 \times 10^{22}$ cm, and $D_0 = 10^{28}$ cm^2/sec, we find that the argume argument of the exponential is $r^2/4Dt \gg 1$ at $E \leq E_{cr}$ and decreases with increasing E. As a result, the differential energy spectrum N_{nonst} has a maximum at values of E satisfying the condition $r^2/4Dt \sim 1$ (Fig. 1)[3].

Figure 2 shows the partial integral spectra of cosmic rays of stationary and nonstationary origin, and also the summary integral spectrum. The z-distributions of the stationary component at the earth and of the nonstationary component in the source were chosen in accord with [19]. The shaded region on Fig. 2b corresponds to the experimental values of the primary spectrum, obtained by various authors [3, 6 - 11] from the particle-number spectrum. The point at 5×10^{19} eV is taken from [17]. Thus, the considered model explained the dual change of the form of the primary energy spectrum and the possible existence of cosmic rays with energies $\geq 3 \times 10^{19}$ eV. The chemical composition, obtained within the

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[1] The question of cosmic rays of nonstationary origin was considered in [19] in connection with the problem of high-latitude curoff of the energy spectrum.

[2] E_{cr} is the proton energy, starting with which the diffusion coefficient becomes dependent on E, and z is the charge of the primary nucleus.

[3] At the chosen parameters, the diffusion range is $\lambda = 3D/c = 10^{18}(E/E_{cr})$ cm. The condition for the applicability of the diffusion approximation is $r \gg \lambda \geq \rho$, where $\rho = E/300H$. At $E_{cr} \sim 10$ eV and $H \sim 3 \times 10^{-6}$ Oe, this condition is satisfied for any E, if it is recognized (see Fig. 3) that the predominant role at large E is played by nuclei with large z.

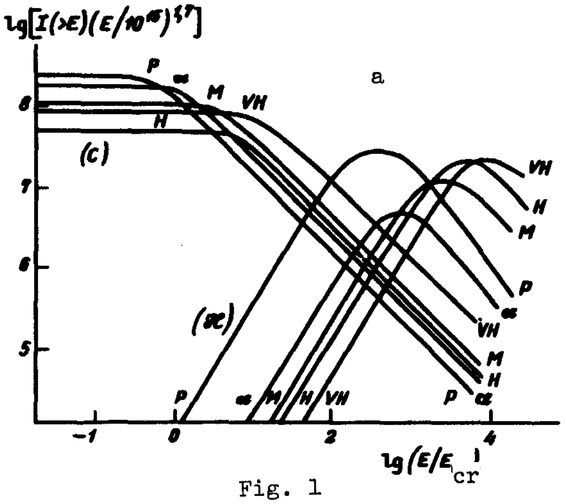

Fig. 1

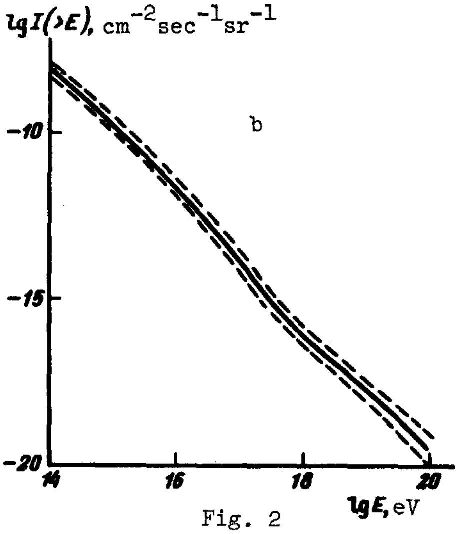

Fig. 2

framework of the considered model (Fig. 3) does not contradict the rather scanty experimental data presently available concerning the composition in the energy range $E = 10^{15} - 2 \times 10^{17}$ eV. There are no experimental data at high energies.

Table I

Nucleus	P	a	M	H	vH
Composition on earth %	38	28	15	7	12
Composition in sources,%	34	5	14	21	26
$Q_{nonst}/Q_{st} \cdot T$	2.8				21.7

Table I shows the chemical composition of the stationary component at the earth (in the energy region $E < E_{cr}$), the chemical composition in the sources of the stationary and nonstationary components, and also the ratio of the source intensities of the nonstationary and stationary components of the proton and heavy-nucleus spectra. (The lifetime of the stationary component was assumed to be $T = 3 \times 10^8$ years.) Using the obtained source intensity ratio, we find that on the average the cosmic-ray flux per unit volume from the disc is about 20 times larger than from the halo. This result is in good agreement with the experimental data of [20] and [21], where it was found that the flux per unit volume of the radio emission and the flux of λ rays from the disc is larger by tens of times than from the halo.

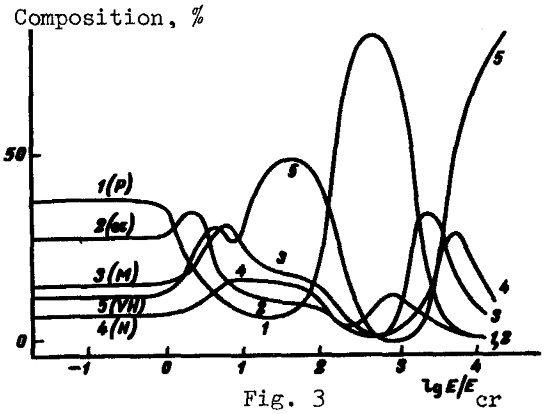

Fig. 3

The anisotropy coefficient at energies for which the nonstationary component predominates does not depend in the model under consideration on the diffusion coefficient, and is determined by the time elapsed from the instant of the explosion. Its value $\delta = (3/2) \times (r/ct) = 5\%$ does not contradict the experimental data

Table II).

Table II

E, eV	$10^{14}\div10^{15}$	10^{16}	$5\cdot10^{16}$	$5\cdot10^{17}$	10^{18}	10^{19}
δ, %	0,1 [24]	0,7 [10]	3,0 [10]	3,4 [23]	10 [11]	30 [11]

Table II lists the upper limits of the variation amplitudes, for which only the orders of magnitude are given. At lower energies, when the main role is played by the stationary component, $\delta \approx (0.01 - 1)\%$ at the chosen model parameter, and there is no contradiction with the data of Table II within the limits of the experimental errors.

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INFLUENCE OF TEMPERATURE PERTURBATIONS ON PLASMA DIFFUSION IN TOROIDAL SYSTEMS

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The success of the "Tokamak" program [1], which has made it possible to reduce the particle loss from the trap to the level of the classical loss due to pair collisions [2], has attracted the interest of specialists to the review, previously initiated by us, of the theory of transport phenomena in a rarefied plasma in a toroidal system [3]. Quite recently,