$$\sigma = [4a\sigma_0 E/\pi m(m+2E)][(E+m)\ln(1+2E/m) - 2E]\ln(\omega_2/\omega_1) \quad (3)$$

where $a = 1/137$ is the fine structure constant, $\sigma_0 = 8.3\times10^{-45}$ cm^2, and E is the neutrino energy. The cross section for the production of a photon of energy higher than 30 keV can be easily estimated, namely, at a neutrino energy E = 1 MeV, ω_1 = 30 keV, and ω_2 = 0.1 MeV we obtain $\sigma \approx 3\times10^{-47}$ cm^2 (such photons can be registered in 0.3% of all ν-e scattering cases). It follows from (3) that the relative contribution of the process (1) increases with increasing interval of the energies of the registered photons and with increasing energy of the primary neutrino.

Owing to the high intensity of the neutrino flux in the energy region $\sim$ 1 MeV, in an electronic detector containing $\sim$ 300 m^3 of liquid argon, one can expect about a hundred inelastic events per year from only one monochromatic line of the solar spectrum — a neutrino of energy 0.86 MeV (assumed flux $\sim 10^9$ cm^{-2}sec^{-1}).

Thus, the magnitude of the effect of process (1) is comparable with the expected effect from the "boron" neutrinos in the known instrument of Davis [5]. At the same time, we can obtain more direct information on the processes occurring on the sun, since neutrinos of energy $\sim$ 1 MeV are produced during earlier stages of thermonuclear fusion than "boron" neutrinos. The accuracy with which the direction of the neutrino flux is registered is $\sim 10°$. Consequently, the solar origin of the registered neutrinos can be uniquely verified, in principle, whereas the "blind methods," including the radiochemical method used in the Davis instrument, leave open the question of the origin of the neutrino.

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STRUCTURE OF POMERANCHUK POLE AND INCLUSIVE SPECTRA

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We consider the connection between the approach to scaling in the inclusive reactions and the clustering of the produced particles. The analysis is carried from the point of view of the multiperipheral model. It is shown that the behavior of the inclusive spectra depends on the ratio of the densities with respect to the rapidity of the detected particles in fragmentation clusters (resonances) and in central ones.

The question of the dynamics of multiple particle production is at present of particular interest, since the new experimental data announced daily, obtained from high-energy accelerators (Serpukhov, Batavia, ISR-CERN) make it possible to verify the validity of various theoretical models, and also take into account in them many important factors.

Of particular interest from among the latest sutdies are the approach to scaling in the central region of inclusive spectra, and the appreciable correlations observed experimentally in two-particle inclusive reactions, and point to clustering of the produced particles [1].

We emphasize that in the investigation of interactions at high energies (E $\gtrsim$ 30 GeV) one deals in essence with a determination of the structure of the leading vacuum singularity (the Pomeranchuk pole), since the contribution of this singularity is predominant at such energies.

We consider in this paper, in the multiperipheral model [2], the connection between the approach to scaling in the central region of single-particle inclusive spectra and correlations (the clustering effect), and show how the behavior of the inclusive spectra can find a natural explanation. From the point of view of the multiperipheral model, this means that we admit of production of clusters at the nodes of the diagram (models of this type were considered in [13, 14]).

The approach to scaling in the central region was discussed in many papers [3 - 7]. Interest in them is due to the fact that in the Mueller-Kancheli diagrams [8, 9] (Fig. 1) the behavior of the inclusive spectrum is determined by the constant g in the central vertex (the wavy lines correspond to reggeons, namely the pomeron P and the secondary trajectories R). In this case we have

$$\frac{d\sigma}{dy}\Big|_{y_{s.p.}=0} = a + g s^{-1/4}, \qquad (1)$$

where s is the square of the total energy of the colliding particles in the c.m.s. If we assume that g > 0, then formula (1) corresponds to approach to scaling from above, in contrast to experiment (e.g., for π spectra in pp collisions), thus clearly indicating a growth of $d\sigma/dy|_{y_{s.p.}=0}$ with increasing energy [3, 5] (which corresponds to g < 0 in formula (1)). At the same time, g > 0 corresponds to a summary positive contribution of the secondary Regge trajectories, as is always observed in elastic reactions. Furthermore, to describe the spectra of positive and negative ions it becomes necessary to ascribe to the contributions of the secondary trajectories (P' and ρ) relative signs [10] that differ from those observed in elastic reactions, and this, in turn, leads to violation of the duality concepts as applied to the analysis of inclusive reactions.

We note that the "double-hump" dσ/dy spectrum obtained in the Mueller-Kancheli analysis (with positive constant g) corresponds in effect to clustering at the edges of the multiperipheral chain.

On the other hand it is known that clustering is described successfully with the aid of secondary Regge trajectories (investigation of correlations in two-particle inclusive reactions with the aid of Mueller-Kancheli diagrams [10]) and this, according to duality, is equivalent to considering clustering as an aggregate effect of resonances. With increasing energy, the edge (fragmentation clusters), moving apart in rapidity, can produce a "dip" in the center of the spectrum, and by the same token an approach to scaling from above.

If, however, new clusters are produced with increasing energy along the multiperipheral chains, such a situation is not obligatory, and the behavior of the spectra is determined by the ratio of the density, with respect to rapidity, of the detected particles in the edge and central clusters[3)]. If, for example, the pion density with respect to rapidity is smaller for the edge clusters in pp collisions (i.e., in fact, in the decay of baryon resonances), then in the central clusters (corresponding, in the main, to resonances in the ππ system), then we should observe an increase of d /dy $y_{s.p.}=0$ for pion spectra in pp collision. An analysis of πp and pp collision

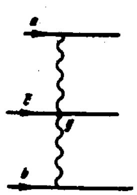

Fig. 1

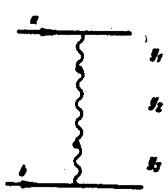

Fig. 2

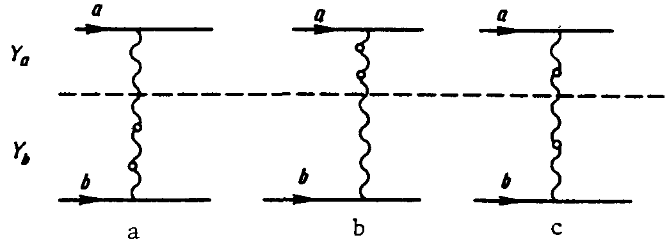

Fig. 3

does show indeed that the multiplicity in pion clusters can be higher [11, 12]. In this case we should, e.g., expect also a much "faster" scaling (smaller correction terms) for π^+ spectra in π^+p collisions in comparison with pp collisions, since one of the edge cluster coincides with the central ones in the former case. At the same time, the behavior of the π^- spectra in π^+p and pp collisions should be similar if one proposes the absence of (exotic) resonances in the $\pi^+\pi^+$ system (a more detailed behavior of different spectra will be considered in a paper in Yadernaya Fizika (Sov. J. Nuc. Phys.)).

We represent the forward elastic scattering amplitude (which is connected with the total cross section in accordance with the unitarity condition) in the form of Fig. 2, where the points correspond to two-particle (mainly two-pion) exchanges connecting the edge clusters (which are different for different colliding particles) and the central ones (which are the same in all processes). The amplitude of Fig. 2 corresponds to the expression

$$A(Y) = \int A_a(y_1)\tilde{A}(y_2)A_b(y_3)\delta(y_1 + y_2 + y_3 - Y)dy_1 dy_2 dy_3 , \qquad (2)$$

where Y = ln s, y_1, y_2, and y_3 are the rapidity intervals for the edge clusters and the aggregate of central clusters (see Fig. 2), A_a and A_b are the amplitudes describing the edge clusters, and $\tilde{A}$ is the aggregate of the central clusters. Since we plan to consider subsequently an inclusive spectrum of particles that are separated in rapidity by Y_a and Y_b from the initial particles ($Y_a + Y_b = Y$), we represent the integral in (2) in the form of three terms, choosing correspondingly the integration limits as shown in Fig. 3.

From the point of view of the Mueller-Kancheli diagrams, Figs. 3a and 3b correspond to production of a particle from clusters made up of the initial particles a and b, respectively, and Fig. 3c corresponds to production of a particle from any of the central clusters. We denote the corresponding contributions of the diagrams of Fig. 3 to the total cross sections of B_a, B_b, and B: by

$$\sigma_t = B_a + B_b + B . \qquad (3)$$

For the inclusive cross sections we have

$$\frac{1}{\sigma}\frac{d\sigma}{dy} = \frac{1}{\sigma}(g_a B_a + g_b B_b + gB), \qquad (4)$$

where g_a and g_b correspond (in the mean) to the density of the detected particles in the edge clusters, and g corresponds to the "asymptotic" particle density in the central clusters (in the "Pomeranchuk pole").

From (3, 4) we have

$$\frac{1}{\sigma}\frac{d\sigma}{dy} = \frac{1}{\sigma}[g(B_a + B_b + B) - (g - g_a)B_a - (g - g_b)B_b] =$$
$$= \frac{1}{\sigma}[g\sigma - (g - g_a)B_a - (g - g_b)B_b] . \qquad (5)$$

Formula (5) shows that the behavior of the inclusive spectra is indeed determined by the ratio of the rapidity density (i.e., by the constants g_a, g_b, and g) in the edge and central clusters. If B_a and B_b are parametrized in the form $\exp(-Y_a/2)$ and $\exp(-Y_b/2)$, corresponding to a description of the clusters with the aid of secondary Regge trajectories, then in the case $g > g_a$, g_b we have for $(1/\sigma)(d\sigma/dy)_{y_{s.p.}=0}$ formula (1) with an "effective" negative constant g (the Ferbel parametrization [3], which agrees well with the experimental data).

In this brief article we wish to call attention to a qualitative effect connected with different characteristics of the clusters of the produced particles and their manifestation in inclusive spectra. A more detailed analysis causes the "constants" g_a, g_b, and g to be dependent on more detailed characteristics of the decays of the resonances clusters, and they are determined in essence by the single-particle inclusive spectra of the resonance decays. In addition, the parametrization of B_a and B_b (see above) in the form $\exp(-Y_a/2)$ and $\exp(-Y_b/2)$ is also approximate. In a more detailed analysis it is necessary, for example, to take into account the branch cuts and other Regge trajectories.

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3) We note that the central constant g in Fig. 1 characterizes (for $(1/\sigma)(d\sigma/dy)$) precisely the density of the produced particles with respect to rapidity.

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STRUCTURE OF THE GIANT DIPOLE RESONANCE OF THE NUCLEI Er^{166} and Hf^{178}

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We measured the cross sections σ_γ for the absorption of γ quanta by the nuclei Er^{166} and Hf^{178}. These cross sections have an intermediate structure that can be interpreted in the spirit of the dynamic collective model of giant resonance.

The belatron of our Institute was used to measure the photoneutron yield curves for Er^{166} and Hf^{178}. The measurements were made by a method of automatic scanning [1] with respect to the energies E_0 of the accelerated electrons from the threshold of the (γ, n) reaction to 20 – 21 MeV. For each element we obtained two independent yield curves in steps $\Delta E_0 = 0.2$ MeV, shifted 0.1 MeV relative to each other. The statistical accuracy of the measurement was better than 0.1% at $E_0 \sim 20$ MeV. The photoneutrons were registered with a spherical detector with BF_3 counters [1]. The cross sections $\sigma(\gamma, Tn)$ for photoneutron production we calculated from the yield curves by the Penfold-Leiss method (with intervals $\Delta E = 0.2$ MeV) and were subsequently reduced by the method of [2], which suppresses the false fluctuation structure. This procedure ensures an energy resolution ~ 0.6 MeV. The absolute normalization of the cross section was carried out by comparing the photoneutron yields from the investigated samples and deuterium. To determine the multiplicity of the photoneutron emission, the yields of the reactions (γ, n) and $(\gamma, 2n)$ were separated by a statistical method [3, 4]. In these measurements we used a specialized computer [4] operating on line with the experimental apparatus, and a scintillation neutron detector [5] with efficiency $\sim 40\%$. The measured cross sections $\sigma(\gamma, 2n)$ do not contradicy the statistical theory of neutron emission. The level-density parameter $\underline{a}$ was found to equal 6.1 ± 2.5 MeV^{-1} and 17.7 ± 7.3 MeV^{-1} for Er^{166} and Hf^{178}, respectively. These values of $\underline{a}$ were used to calculate the total γ-quantum absorption cross sections σ_γ from $\sigma(\gamma, Tn)$ by means of the statistical-theory formulas. The cross sections σ_γ are shown in Figs. 1 and 2. For Er^{166} we determined σ_γ also from the cross section $\sigma(\gamma, Tn)$ calculated by the regularization method [6, 7]. The resultant