where $\mathbf{k}$ and ω are the momentum and energy of an excitation, and

$$\begin{aligned}\gamma_{11}=\gamma_{22}&=g^2\theta(p)\theta(p')(u_{p+k/2}u_{p'-k/2}+v_{p+k/2}v_{p'-k/2})\\&\times(u_{p-k/2}\,u_{p'+k/2}+v_{p-k/2}v_{p'+k/2}),\\ \gamma_{12}=\gamma_{21}&=g^2\theta(p)\theta(p')(u_{p+k/2}v_{p'-k/2}-v_{p+k/2}u_{p'-k/2})\\&\times(u_{p-k/2}\,v_{p'+k/2}-v_{p-k/2}u_{p'+k/2}).\end{aligned}\tag{3}$$

Thanks to the degeneracy of the nuclei (3), the set of integral equations becomes an algebraic system, and the condition that this can be solved gives us an equation for $\omega(k)$. The integrals occurring in the dispersion relation are evaluated for small values of k and ω. The result is $\omega^2 = c^2k^2$, $c^2 = p_0^2/3m^2$.

It is necessary to emphasize that our result cannot be applied to a system of charged particles. In that case, by virtue of the Coulomb interaction, the sound vibrations go over into plasma waves of high frequency $(\omega^2 = 4\pi e^2 n/m)$.

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THE CROSS SECTION OF THE PION — NUCLEON INTERACTION IN THE HIGHER ENERGY REGION

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In a previous paper,[1] it was shown by the author that both for the model of a nucleus with homogeneous density and sharp boundaries, and also for the nuclear model in which the decrease in the density begins at the center of the nucleus, we must renounce the possibility of choosing a value of r_0 in the expression $R = r_0A^{1/3}10^{-13}$ cm (on the basis of these models) that will be the same for all nuclei investigated (R = nuclear radius, A = atomic weight). Also excluded is the William's density distribution[2] because of the great extension of such a nucleus.

Investigation of the cross section of the interaction of π^- and π^+ mesons of different energies with heavy nuclei[3] has shown that, with an accuracy to within 3%, the radial distribution of the protons and neutrons is identical. On this basis, it can be assumed that the distribution of nucleons in the nucleus coincides with the distribution of protons, which is determined in experiments on electron scattering. Application of the homogeneous, smooth model of the nucleus, obtained from experiments on the scattering of electrons for the analysis of cross sections of nuclear interactions of protons with energies from 0.9 to 34 Bev with nuclei of lead and graphite has given satisfactory results.[1]

In the present work, on the basis of experimental data relative to cross sections of inelastic collision of pions with graphite and lead nuclei[4,5] at the energies mentioned, we have carried out calculations of the cross section of inelastic interaction and the opacity of nuclei, making use of a homogeneous smooth model of the nucleus for this purpose. If we assume for the cross section of the interaction of pions with nucleons $\bar{\sigma}(\pi) = 33$ mbn, then the computed values of the cross section of the interaction coincide with the experimental for values of the radial parameter of the smooth distribution $c = (1.14 \pm 0.04) \times 10^{-13} A^{1/3}$ cm. With consideration of experimental errors, $\bar{\sigma}(\pi) = 33 \pm 4$ mbn. Here it has been assumed that the range of the fall-off of the density of the nucleons is the same as for protons.[1]

Similar results are obtained in the analysis of the cross section of interaction of negative pions with energies of 0.97 Bev with nuclei under the use of a homogeneous smooth model of the nucleus.[6]

The value of the cross section of the interaction of pions with nucleons $\overline{\sigma}(\pi) = 33 \pm 4$ mbn used by us in this research is, in the region under study, in excellent agreement with the results which follow from a direct measurement of the cross section of pion-nucleon interaction in the region of energy reached by present-day accelerators. Thus, for example, the value of $\overline{\sigma}(\pi) = 31 \pm 2$ mbn was obtained[7] by bombardment of hydrogen targets with pions of energy 1.9 Bev. At an energy of 4.4 Bev, $\overline{\sigma}(\pi) = 30 \pm 5$ mbn.[8] It then follows that for energies higher than 1.9 Bev, the interaction cross section of pions with nucleons does not change with energy, at least up to energies of 34 Bev.

Evidently, the cross section of interaction of pions with nucleons in the region of high energies tends to some limit $\sim 30 - 32$ mbn, which coincides with the cross section of nucleon-nucleon interaction for the energies considered.[1] This can be a consequence of the finiteness of the dimensions of the nucleons. Actually, calculation (see Ref. 9) shows that under the assumption of finite dimensions of the nucleons, the limiting value of the cross section of interaction of pions at high energies is $\overline{\sigma}(\pi) = 30$ mbn.

Thus our data show that the nuclear and electromagnetic radii of nuclei coincide if use is made of a homogeneous smooth distribution.

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ELASTIC SCATTERING OF HIGH ENERGY PARTICLES BY DEUTERONS

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THE study of the interaction of high energy particles with deuterons makes it possible to draw some conclusions on the character of the motion of nucleons in the deuteron. In the deuteron the nucleons are preferentially located at great distances from each other; therefore the fast particles interact only with one of the nucleons of the deuteron, leading to breakup of the deuteron or to the reaction of stripping. The theory of these processes has been well studied. However, in the deuteron, the nucleons can be found with some probability at sufficiently small separation distances, and then an incident particle with wavelength $\lambda\!\!\!^{-}$ less than the separation of the nucleons in the deuteron will be scattered elastically. This means that in such collisions, the incident particle transfers a significant part of its momentum to the deuteron.

In recent experiments carried out by Leksin[1] on the scattering of protons of 675 Mev on deuterons, there was observed, along with the scattered nucleons, a small number of undestroyed deuterons with high energies (up to 660 Mev). An explanation of this phenomenon was proposed by Blokhintsev[2] as the elastic scattering of the protons by the deuteron. However, the quantitative estimates given by him appear to us to be insufficiently accurate, the more so as the relative probability of this process, according to Blokhintsev, does not depend on the momentum of the incidence particle. A quantitative estimate is given below of the relative probability of this process with the use of the wave function of the deuteron obtained by the method of Tamm and Dancoff.[3]

The cross section of elastic scattering of fast