DETERMINATION OF THE RADIUS OF STRONG INTERACTION OF Pb AND THE MEAN FREE PATH OF THE π^0 MESON IN NUCLEAR MATTER

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It was shown in [1 - 3] that the main contributions to the photoproduction of π^0 mesons on nuclei at high energies and small meson-emission angles are made by Coulomb production and coherent production. The absence of interference between these processes makes it possible to separate the coherent production from the Coulomb production and to write down the cross section for coherent production of π^0 mesons in the form

$$d\sigma/d\Omega = CA^2|F(q)|^2\sin^2\theta, \tag{1}$$

where A is the mass number of the target nucleus, $F(\vec{q})$ is the form factor of the nucleus, θ is the angle of emission of the π^0 meson, and $C\sin^2\theta$ is the square of the amplitude of production of the π^0 meson on the nucleon and is independent of the spin and isospin.

We analyze in this paper the results of our investigations of the photoproduction of π^0 meson on the lead nucleus at a primary-photon energy 1.1 GeV [4], in order to obtain the parameters of the nucleon distribution in the nucleus and to determine the mean free path of the π^0 meson in nuclear matter.

We have compared the experimentally measured cross sections with the results of calculations by formula (1). The form factor $F(\vec{q})$ was calculated by the method developed in [1], with allowance for the interaction of the π^0 mesons in the final state with the nucleus. The density distribution functions of the nucleons in the nucleus were chosen in accord with the uniform model and the Woods-Saxon model. The uniform model is characterized by a radius R and the Woods-Saxon model is described by a radius R and a parameter a = 0.545 F. The free path λ of the π^0 meson in the nucleus and the value of R were determined by minimizing the sum

$$\sum_{i=1}^{13} \frac{d\sigma_i/d\Omega - d\sigma_i^T/d\Omega}{\sigma_i^2}, \tag{2}$$

where $d\sigma_i/d\Omega$ is the experimentally obtained differential cross section, $d\sigma_i^T/d\Omega$ is the theoretical cross section, and σ_i is the measurement error.

Table 1

Nucleon distribution model	R, F	λ, F	χ^2	Degrees of freedom	$P(\chi^2)$
Uniform	$7.10^{+0.10}_{-0.08}$	$3.10^{+0.11}_{-0.13}$	1.11	11	~1
Woods-Saxon	$7.45^{+0.12}_{-0.10}$	$4.92^{+0.12}_{-0.14}$	0.99	11	~1

Table 2

Method	Nucleon distribution model	r_0, F	Reference
π^0-meson photoproduction on nuclei	uniform	1.22 ± 0.03	[5]
	trapezoidal	1.15 ± 0.03	
π^0-meson photoproduction on nuclei	uniform	$1.23^{+0.04}_{-0.03}$	[6]
ρ-meson photoproduction on nuclei	Woods-Saxon	1.12 ± 0.02	[7]
π^0-meson photoproduction on nuclei	uniform	$1.20^{+0.02}_{-0.01}$	Present work
	Woods-Saxon	$1.26^{+0.02}_{-0.01}$	

The results of the experimental data are given in Table 1. We see from the table that both models agree equally well with the experimental data.

Writing down the radius of the nucleus in the form $R = r_0 A^{1/3}$, we can compare the results of this paper with the results of other experiments in which the radius of the strong interaction of the nuclei was measured (Table 2).

The obtained values of λ are in qualitative agreement with the values calculated from the total πN-scattering cross sections [8, 9].

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LUMINESCENCE OF SOLID ORGANIC DYES BOMBARDED BY THERMAL HYDROGEN ATOMS

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In [1] we have observed glow of solid aromatic substances bombarded by H atoms (H-luminescence or HL). This glow was attributed to chemoluminescence resulting from the reaction of the joining of the hydrogen atom to the aromatic molecule