to condense into "drops" during the exciton lifetime. This fraction, however, increases rapidly when the concentration approaches the critical value equal to the concentration in the "drop." As the carriers gradually die out, the volume of the "drops" decreases gradually, leading to a smoother dependence of the modulation on the concentration. It follows from the experimental data presented here that the density of the electron-hole pairs in the metallic phase is approximately equal to 10^{16} cm^{-3} and increases somewhat with decreasing temperature.

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LIFETIME OF NEUTRAL PION

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In the present paper we report preliminary results of an experiment aimed at the investigation of photo production of π^0 mesons in the Coulomb field of the nucleus (the "Primakoff effect") [1].

The connection between the cross section of the "Primakoff effect" and the neutral-pion lifetime was used in [2 - 5] to determine the lifetime τ_{π^0} of the π^0 meson. The accuracy of this method is limited essentially by the angular resolution of the apparatus, at best 0.5° [4].

Our experimental setup is shown in Fig. 1. The bremsstrahlung beam from the "Sirius" electron synchrotron with maximum energy 1.1 GeV was fed through a collimator (1) or 1 mm diameter to a lead target (2) 0.1 mm thick. The target was placed in the field of a magnet (3). The gamma quanta from the decaying meson passed through a conical opening with aperture angle 32° in a lead shield (4). Located 51 cm from the target was placed a spark chamber SC_1 with two 1-cm gaps, and spark chamber SC_2 with

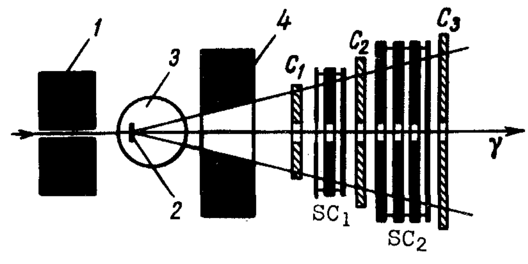

Fig. 1. Arrangement of apparatus

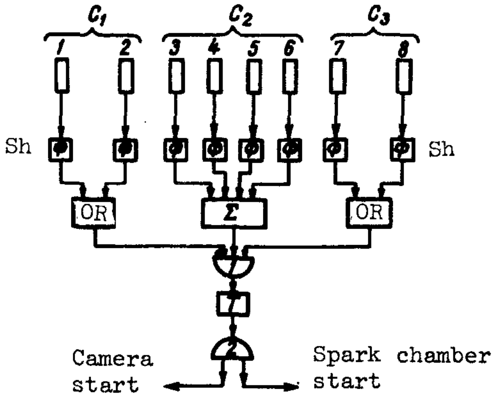

Fig. 2. Block diagram of circuitry

three 1-cm gaps. The spark chambers contained lead plates with a total of about 5 radiation units of matter.

The scintillation counters C_2 and C_3 registered the electromagnetic showers. Counter C_1 prevented operation of the spark chambers by charged particles. The counters had organic scintillators in the form of discs 1 cm thick. The discs were assembled of two sectors for counters C_1 and C_3 and of four sectors for counter C_2. The spark chambers and the scintillation counters were placed along the beam axis and had apertures forming a channel for the passage of the bremsstrahlung gamma quanta. The apertures in the outer plates of the spark chambers were sealed with mylar film.

Figure 2 shows the electronic circuitry controlling the high-voltage supply of the spark chambers and the RFK-5 motion-picture camera. The signals from the anodes of the FEU-30 photomultiplier passed through a shaping circuit Sh, an "OR" circuit, and an adder Σ to the selection circuit (1) that triggered the flip-flop T in the case when a signal from counter C_3 arrived simultaneously with two signals from counter C_2 and there was no signal from counter C_1. The flip-flop T turned on, through a pulse doubler (2), the pulse supply to the spark chambers and to the motion picture camera.

Two projections of the tracks in the spark chambers were photographed, and the frames selected were those on which there were no tracks in the first gap of SC_1, there were two tracks in the second gap, while in SC_2 there were two showers, each corresponding to an energy not lower than 400 MeV. The energy was estimated from a calibration curve obtained from preliminary measurements with a magnetic spectrometer. From the coordinates of the decay gamma quanta we could determine their divergence angle ϕ and the angle θ between the bremsstrahlung-beam axis and the bisector of the angle ϕ. We discarded events with ϕ smaller than ϕ_{min}, defined by the relation

$$\sin(\phi_{min}/2) = \mu/E,$$

where ϕ_{min} is the minimum divergence angle of the decay gamma quanta for a π^0 meson with mass μ and energy $E \approx 1.1$ GeV. Events with $\phi < \phi_{min}$ were connected with uncorrelated gamma quanta from the double production of π^0 mesons on the nucleus. They had a uniform angular distribution. Their contribution was approximately 5% and was subtracted from the bisector distributions.

Owing to the isotropy of the decay of the π^0 meson in the meson rest system, the divergence angle of the decay gamma quanta ranged from ϕ_{min} to 180° and the deviations of the flight of the π^0 mesons from the bisector were determined by the expression

$$\cos\delta = (\cos\phi/2)/\beta,$$

where β is the π^0-meson velocity.

It is shown in [6] that if the distribution of the bisectors is expanded in Legendre polynomials

$$d\sigma_{\text{bis}}/d\Omega = \sum_{i=1}^{n} a_n P_n(\cos\theta_{\text{bis}}),$$

and then the expansion coefficients are divided by the quantity

$$\xi_n = \int_{\frac{1}{\beta}\cos\frac{\phi_{max}}{2}}^{1} \left(\frac{(1-\beta^2)uP_n(u)\,du}{\sqrt{1-u^2}(1-\beta^2u^2)^{3/2}}\right),$$

where $u = \cos\delta$, then the obtained expansion

$$d\sigma_{\pi^0}/d\Omega = \sum_{i=1}^{n} (a_n/\xi)P_n(\cos\theta_{\pi^0})$$

describes the meson distribution.

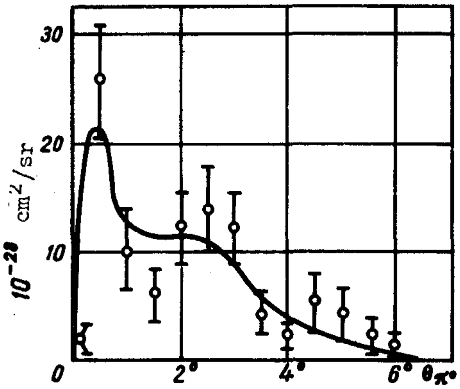

Fig. 3. Distribution of bisectors for $\phi = \phi_{min}$.

To check this method, we constructed the distribution of the bisectors for $\phi = \phi_{min}$ (Fig. 3, the curve was obtained by least squares with allowance for the efficiency of the apparatus) and for $\phi > \phi_{min}$; they coincided within the limits of statistical errors.

π^0-meson lifetime, 10^{-16} sec	Reference
0.73 ± 0.105	[4]
$0.60 \pm^{0.2}_{0.08}$	[5]
0.89 ± 0.18	[8]
0.900 ± 0.073	Our data

For a fraction of the processed material (800 events), we constructed the π^0-meson distribution and compared it with the set of theoretical cross sections [7], from which we determined the quantity

$$\tau_{\pi^0} = (0.900 \pm 0.073)\cdot 10^{-16}\ \text{sec}$$

Thus, the given apparatus made it possible to plot the distribution of the π^0 mesons with angular resolution $\Delta\theta = 7'$, to separate clearly the peaks of the Coulomb and the coherent production, and to determine the lifetime of the neutral meson with accuracy ± 8%. For comparison, the table lists the most accurate values of the π^0-meson lifetime.

The entire material is now being processed, including a complete analysis of the experimental data.

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