and $\Delta\kappa = 0.37$, which is quite satisfactory for such poor statistics. It is expected that different versions of the proposed method will find use in the investigation of new transuranic elements.

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TOTAL CROSS SECTION OF PHOTOPRODUCTION OF π^0 MESONS ON PROTONS AT LOW ENERGIES

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We have measured the total cross section of photoproduction of neutral pions, from the threshold energy of the primary γ quanta to 245 Mev. The measurements were made with the synchrotron of the Physics Institute of the U.S.S.R. Academy of Sciences at 265 Mev, using a liquid-hydrogen target. Using a method described previously,[1] in which a gamma telescope is placed at 90° to the direction of the primary photon beam, we measured simultaneously the entire curve of the yield of decay γ quanta, from threshold energy of primary photons to 250 Mev (in steps of 10 Mev). The smearing in the maximum energy of the bremsstrahlung γ spectrum amounted to ±1 Mev. The yield of the decay photons was plotted with a statistical accuracy of 2 – 3%. The background produced by an empty target was 8 – 10% of the count produced by a hydrogen-filled target. A detailed description of the measurement procedure and of the absolutization of the results obtained was given previously.[1,2]

The dependence of the cross sections of production of decay γ quanta on the photon energy was calculated from the yield curve by the "photon difference" method. As shown by Koester and Mills,[3] the measured yields of the decay γ quanta per photon, at an angle close to 90° in the laboratory system, is connected with a total cross section of photoproduction of π^0 mesons. Thus, if the photoproduction cross section has the following form in the center-of-mass system

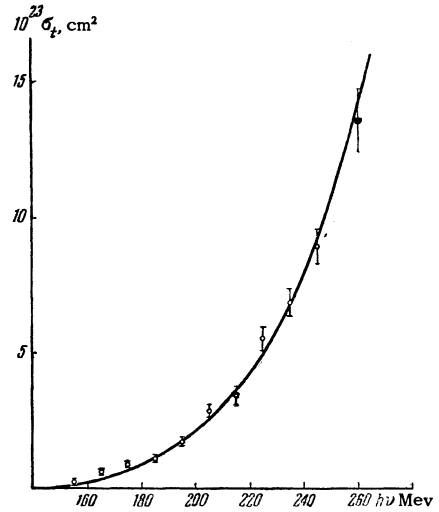
$$d\sigma/d\Omega = A + B\cos\theta + C\cos^2\theta,$$

where θ is the angle of emission of the meson, then the total cross section can be obtained from

$$\sigma_t = 4\pi J\,(90°)\,(A + {}^1/_3 C)/(\alpha A + \beta B + \gamma C), \qquad (1)$$

where J (90°) is the yield of decay γ quanta (per photon) at 90°, while α, β, and γ are functions that vary smoothly with the energy of the primary photon, and are calculated from kinematic considerations and from the γ telescope efficiency curve. Both the quantity β and the coefficient B are small in the energy range considered here, and the term βB in Eq. (1) can therefore be neglected. Measurements of the angular distributions[2] show that the ratio C/A does not change greatly with energy of the primary photons and is close to – 0.6 in the investigated energy range.

The calculated experimental values of σ_t, as functions of the primary-photon energies, are compared in the diagram with the theoretical curve, calculated for the photoproduction amplitudes obtained by solving the dispersion relations of Chew



The total cross section σ_t of π^0-meson photoproduction in hydrogen; ○ – data of this paper, □ – data from reference 5.

et al.[4] The calculations were carried out for $f^2 = 0.08$ and $\omega_r = 2.1$. We neglected in these calculations the contributions made to the total cross section by the amplitudes of the electric-dipole E1 and electric-quadrupole E2 transitions. As can be seen, good agreement is observed between the theoretical curve (which is estimated by the authors of reference 4 to be accurate to ~ 10%) and the obtained results; this agreement is due in final analysis to the fact that the principal contribution to

σ_t is made by the scattering length a_{33}, for which the solution obtained for the dispersion relations of Chew et al. is apparently satisfactory. Deviations of the experimental points from the theoretical curve in the region close to the threshold (up to 180 Mev) indicate that E1 does make a definite contribution to the total cross section.

The variation of σ_t with the energy, obtained in the present work, is in good agreement with the variation of the cross section as obtained by Koester and Mills,[3] but the absolute values given by the latter for σ_t are 30% less.

In conclusion we thank I. A. Erofeev for help in the measurements and for the processing of the experimental data, and to V. I. Gol'danskiĭ and A. M. Baldin for valuable advice.

[1] Vasil'kov, Govorkov, and Kutsenko, Приборы и техника эксперимента (Instruments and Measurement Engg.) in press.

[2] Vasil'kov, Govorkov, and Gol'danskiĭ, J. Exptl. Theoret. Phys. (U.S.S.R.) **37**, 11 (1959), Soviet Phys. JETP, this issue, p. 7.

[3] L. J. Koester and F. E. Mills, Phys. Rev. **105**, 1900 (1957).

[4] Chew, Goldberger, Low, and Nambu, Phys. Rev. **106**, 1345 (1957).

[5] McDonald, Peterson, and Corson, Phys. Rev. **107**, 577 (1957).

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THREE-ELECTRON DECAY OF THE MUON

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In measuring the asymmetry of the angular distribution of the electrons from $\pi \rightarrow \mu \rightarrow e$ decay, we observed an event in which three relativistic electrons escaped from a stopped muon. A microprojection of this event is shown in Fig. 1. All three electrons from the muon decay have a large dip angle, and therefore accurate measurements of grain density are not significant. Nevertheless the grain density was close to that of relativistic particles, and consequently they have in each case an energy above 1 Mev. The muon was stopped in the last pellicle of an emulsion stack, and all decay electrons escaped from the emulsion stack.

The recorded part of the electron tracks consisted of $L_{e_1} = 455\,\mu$, $L_{e_2} = 562\,\mu$, and $L_{e_3} = 455\,\mu$.

An additional argument for the energy of all the electrons being sufficiently large is the rectilinearity of their trajectories in the recorded part of the track. The muon track was 598-μ long, while the average track length for muons from $\pi \rightarrow \mu$ decay is $602\,\mu$ in R-NIKFI emulsion. The angles between the electrons are $\theta_{12} = 8.6°$, $\theta_{13} = 10.6°$, and $\theta_{23} = 10.5°$. From the microprojection it is evident that the event is not a three-particle decay of the muon ($\mu \rightarrow 3e$), since in that case the electrons would have to be coplanar with zero total momentum. It is not possible to interpret the observed event as the decay of a muon into an electron and a photon with a subsequent conversion of the latter at the point of decay into an electron-positron pair (Dalitz effect). In such a process the photon and consequently also the components of the pair must escape to the side opposite from the decay electron.

The present event can be interpreted as a decay $\mu^+ \rightarrow e^+ + e^+ + e^- + \nu + \tilde{\nu}$. In this interpreta-

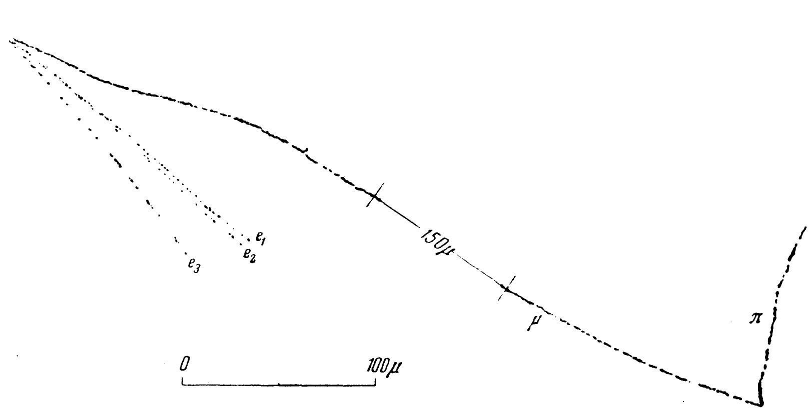

FIG. 1. Microprojection of the three-electron decay of a muon.

Vacuum Tubes (see Methods and Instruments)
Viscosity (see Liquids)
Wave Mechanics (see Quantum Mechanics)
Work Function (see Electrical Properties)
X-rays
Anomalous Heat Capacity and Nuclear Resonance in Crystalline Hydrogen in Connection with New Data on Its Structure. S. S. Dukhin — 1054L.
Diffraction of X-rays by Polycrystalline Samples of Hydrogen Isotopes. V. S. Kogan, B. G. Lazarev, and R. F. Bulatova — 485.
Investigation of X-ray Spectra of Superconducting CuS. I. B. Borovskiĭ and I. A. Ovsyannikova — 1033L.
Optical Anisotropy of Atomic Nuclei. A. M. Baldin — 142.

ERRATA TO VOLUME 9

On page 868, column 1, item (e) should read:

(e). Ferromagnetic weak solid solutions. By way of an example, we consider the system Fe-Me with A2 lattice, where Me = Ti, V, Cr, Mn, Co, and Ni. For these the variation of the moment m with concentration c is

$$dm/dc = (N_d)_{Me} \mp 0.642 \; \{8\,(2.478 - R_{Me}) + 6\,|2.861 - R_{Me}| \mp [8\,(2.478 - R_{\mathrm{Fe}}) + 6\,(2.861 - R_{\mathrm{Fe}})]\},$$

where the signs – and + pertain respectively to ferromagnetic and paramagnetic Me when in front of the curly brackets, and to metals of class 1 and 2 when in front of the square brackets. The first term and the square brackets are considered only for ferromagnetic Me. We then have dm/dc = −3 (−3.3) for Ti, −2.6 (−2.2) for V, −2.2 (−2.2) for Cr, −2 (−2) for Mn, 0.7 (0.6) for Ni, and 1.2 (1.2) for Co; the parentheses contain the experimental values.

ERRATA TO VOLUME 10

Page	Reads	Should Read
224, Ordinate of figure	10^{23}	10^{29}
228, Column 1, line 9 from top	3.6×10^{-2} mm/min	0.36 mm/min
228, Column 1, line 16 from top	0.5 mm/sec	0.05 mm/min
329, Third line of Eq. (23a)	+(1/4 cosh r +...	+1/4(cosh r +...
413, Table II, line 2 from bottom	−0.0924±	−1.0924±
413, Table II, line 3 from bottom	+1.8730±	+0.8370±
479, Fig. 7, right, 1st line	92 hr	9.2 hr
499, Second line of Eq. (1.8)	$+\tilde{k}\sin^2\alpha/\omega_N^2 + \langle c^2\tilde{k}^2 \ldots$	$+\left(\tilde{k}/\omega_H\right)^2 \sin^2\alpha \; \langle c^2\tilde{k}^2 \ldots$
648, Column 1, line 18 from top	18 × 80 mm	180 × 80 mm
804, First line of Eq. (17)	$-{}^1/_3\left(\alpha_x^2\alpha_y^2 + \ldots\right.$	$\ldots -3\left(\alpha_x\alpha_y^2 + \ldots\right.$
967, Column 1, line 11 from top	$\sigma(N', \pi) \approx 46\,(N', N')$	$\sigma(N', \pi) > \sigma(N', N')$
976, First line of Eq. (10)	$= \frac{e^2}{3r^2c^4}$	$= \frac{e^2}{3\hbar^2c^2}$
978, First line of Eq. (23)	$\left[\frac{(2\gamma^2 - 1)^2}{(\gamma^2 - 1)\sin^4(\theta/2)}\right.$	$\left[\frac{(2\gamma^2 - 1)^2}{(\gamma^2 - 1)^2\sin^4(\theta/2)}\right.$