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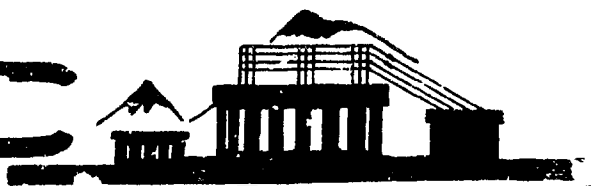
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INVESTIGATION OF ELASTIC ELECTRON-PROTON SCATTERING IN
THE REGION OF SQUARED MOMENTUM TRANSFERS $0.12F^{-2} \leq q^2 \leq 0.5F^{-2}$

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 THE REGION OF SQUARED MOMENTUM TRANSFERS $0.12 F^{-2} \leq q^2 \leq 0.5 F^{-2}$

The results of measurement of relative differential cross sections for elastic electron-proton scattering in the region of small momentum transfers ($0.12 F^{-2} \leq q^2 \leq 0.5 F^{-2}$) are presented. The experiment was performed on the 4.5 GeV internal beam of the Yerevan electron synchrotron. Semiconductor particle detectors and a polyethylene film target have been used. The experimental results allowed to obtain a value for the electric mean square radius of the proton $\langle R_{ep}^2 \rangle^{1/2} = (0.83 \pm 0.03) F$

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ИССЛЕДОВАНИЕ УПРУГОГО РАССЕЯНИЯ ЭЛЕКТРОНОВ ПРОТОНАМИ
 В ОБЛАСТИ КВАДРАТА ПЕРЕДАВАЕМЫХ ИМПУЛЬСОВ $0,12 F^{-2} + 0,5 F^{-2}$

Приводятся результаты измерения относительных дифференциальных сечений упругого электрон-протон рассеяния в области малых передаваемых импульсов $0,12 F^{-2} \leq q^2 \leq 0,5 F^{-2}$. Эксперимент был выполнен на внутреннем 4,5 Гэв электронном пучке Ереванского синхротрона с использованием полупроводниковых детекторов и полиэтиленовой мишени. Результаты измерений позволили получить для среднеквадратичного электрического радиуса протона значение $\langle R_{EP}^2 \rangle^{1/2} = 0,83 \pm 0,03 F$

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INVESTIGATION OF ELASTIC ELECTRON-PROTON SCATTERING IN
THE REGION OF SQUARED MOMENTUM TRANSFERS $0.12F^2 \leq q^2 \leq 0.5F^2$

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1. Introduction.

Experimental study of the elastic scattering of high-energy electrons on protons is a direct source of information on electromagnetic structure of the proton.

As is known [1], in the one-photon exchange approximation the electron-proton elastic scattering cross section is given by Rosenbluth formula

$$\frac{d\sigma}{d\Omega_e} = \sigma_{NS} \left[\frac{(G_E^2 + \tau G_M^2)}{(1 + \tau)} + 2\tau G_M^2 \tan^2(\theta/2) \right] \quad (1)$$

where

$$\sigma_{NS} = \frac{d^2}{4E_0^2 \sin^4(\theta/2)} \cdot \cos^2(\theta/2) \frac{1}{1 + (2E_0/M) \sin^2(\theta/2)}$$

$$\tau = q^2/4M^2$$

q^2 - four-momentum transfer defined as

$$q^2 = \frac{4E_0 \sin^2(\theta/2)}{1 + (2E_0/M) \sin^2(\theta/2)} = 2MT \quad (2)$$

E_0, θ - incident energy and scattering angle of electrons,
 M, T - the mass and kinetic energy of the recoil proton.

α - fine-structure constant,

G_{EP}, G_{MP} - electric and magnetic form factors of the proton.

As can be seen from Eq.(1), the experiment performed at low momentum transfers (at small scattering angles of electrons θ) permits to obtain the electric form factor G_{EP} . Since the electric form factor G_{EP} at small q^2 can be presented in the form

$$G_{EP}(q^2) = G_{EP}(0) \left(1 - \frac{1}{6} q^2 \langle R_{EP}^2 \rangle\right) \quad (3)$$

then in this region of momentum transfers the data on differential cross sections permit to obtain the electric radius of the proton $\langle R_{EP}^2 \rangle^{1/2}$ in model-independent way.

A substantial part of $e - p$ experiment results published up to date belongs to a region of comparatively large q^2 , and the authors of Ref.2 indicate relatively non-high accuracy of data in region $q^2 < 1F^{-2}$. The interest for obtaining more accurate data in the region of low momentum transfers is also caused by a possibility to investigate the non-linear effects of electrodynamics [3].

The results obtained at the first stage of experimental study of small angle $e - p$ scattering performed on the internal beam of the Yerevan synchrotron were published in Refs.[4,5]. Experimental arrangement used at the second stage of these measurements included some modifications which allowed to increase a stability of the results of measurements and extend the investigation to the region of small momentum transfers $0.12F^{-2} \leq q^2 \leq 0.5F^{-2}$ which could not be achieved before.

In the present paper we report the results obtained after joint data processing from two mentioned stages of these measurements. The data processing has been carried out by using more strict algorithm, taking into

account the contribution of the radiative corrections to the measured spectrum of the elastic scattering recoil protons.

2. The Experimental Setup.

The experiment was performed on the 4.5 GeV internal beam of the Yerevan electron synchrotron. The technique of the experiment was similar to the one previously used for investigation of elastic small angle proton-proton and proton-nuclei scattering processes (see [6] and [7,8]). The main features of our method can be summarized as follows:

1. Semiconductor detectors are used to determine the kinetic energy of the recoil protons outgoing from the internal target within the angular range from 84° to 88° .

2. The thickness of the target and the geometry of arrangement are chosen so that the multiple Coulomb scattering and ionization losses unessentially change the scattering angles and energy of detected particles.

3. Counting rate increases due to the multiple traversals of the accelerated electrons through the target.

Fig.1 shows the simplified scheme of the experimental setup mounted on the vacuum chamber of the straight section between the magnets of the accelerator. Polyethylene and carbon targets are set on the rod of the target compartment which is attached to the mentioned vacuum chamber. During the measurements the rod can be displaced so that the edge of the target is located at 40 mm from the equilibrium orbit of the accelerated electrons.

CH₂- target is a thin film circle with 140 mm diameter and about 2μ thickness. The film is fastened to a special vacuum motor rotating at a speed of 3000 turns per minute. During the rotation in vacuum the

film is smoothed out to a plane sloped to the electron beam direction at 45° .

C-target used for background measurements consists of a metal holder having the form of a "fork", and a carbon film fastened to it. The size of the carbon film was 40 x 25 mm and its radiative thickness was approximately equal to one of the CH_2 -film.

During the background measurements the motor of CH_2 -film is switched off and the holder with the carbon film is fixed in the position at which the plane of the carbon film coincides with the irradiated part of the rotating CH_2 -film. During CH_2 -measurements the holder is displaced to the upward-right position and the motor of the CH_2 -target is switched on. In this position the holder doesn't prevent from the circulation of the electron beam and detecting of the recoil particles emitted from CH_2 -film.

Such a construction of the targets permitting to perform their automatic replacement during the operation of the accelerator was favourable for background condition checking and essentially facilitated the selection of a required irradiation mode.

Beam of 4.5 GeV electrons with about 1 mA intensity is directed by means of a special system of local perturbation of the equilibrium orbit ("beam-bump" system) onto a target at the proper moment of the acceleration circle corresponding to the maximum of the magnetic field intensity. Adjustment of the system is performed so that during irradiation (~ 1 msec) the beam is displaced from the edge of the target to its center at 18-20 mm distance. This corresponds to about thousand traversals of the accelerated electrons through the target.

The unit with four semiconductor surface-barrier detectors is attached to the cover of the scattering chamber which is mounted on the mentioned vacuum chamber of the straight section. By means of a special mechanism

this unit can be remotely displaced to the 10 predetermined positions. The distance between the detectors and target is 1.5 m.

Detectors, having sensitive surface 40×10 mm were made of n-type silicon with resistivity $\rho = 6 \text{ K}\Omega\text{-cm}$. The sensitive thickness and energy resolution at applying 350 V to the detectors were 0.8 mm and 60-70 KeV, respectively. The detectors were mounted on the 5 mm bronze collimator, and intended for the separation the strict rectangular 30×10 mm working surface of each detector. The plate was placed so that the largest side of the rectangle collimator hole was parallel to the direction of the electron beam. Special α -source (used for energy calibration) containing Pu^{238} , Pu^{239} and Cm^{239} (5.156 MeV, 5.499 MeV and 5.806 MeV approximately equal intensity lines) was attached to the plate.

Electronics of a spectrometric track of a detector consists of pre-amplifier PA, linear amplifier LA and linear discriminator LD. Pulses from the detector fed to the preamplifier located near it and through ~ 100 m cable were transmitted to the measurement room, where after the amplification by LA they were supplied to the LD. Via mixer grouping analyzer channels in 4 by 1000 channels in each, the pulses entered, then the input of pulse height analyzer DIDAC-4000. The analyzer is controlled by gate former GF triggered at arriving a synchropulse from the accelerator.

Fig.2 shows the typical spectra observed on the analyzer display.

Other electronic units are intended for the following purposes:

VOU - controls the detector voltage offset;

DCU, TCU - are control units for remote displacement of the detectors and remote displacement and replacement of the targets, respectively;

SCU - performs remote setting of the α -source in front of the detectors.

Data on calibration measurements carried out by means of charge gene-

rator ChG and information on α -peak positions allow to perform energy calibration of the spectrometric track.

The kinetic energy corresponding to n -th channel of k -th detector is given as follows:

$$T_{kn} = A_k + B_k \cdot n \quad (4)$$

where A_k and B_k are extracted from calibration measurements by means of the least square method.

3. Differential cross-sections extraction procedure.

As can be seen from Fig.2, spectrum \mathcal{N}_{kn} obtained from k -th detector represents the elastic scattering recoil protons peak located at some background level.

Such character of experimental information defines the problem of differential cross-section extraction as follows:

1. The spectrum is described by the analytical expression of "effect plus background" type:

$$\mathcal{N}_{k+theor}(T) = \mathcal{N}_{kep}(T) + \mathcal{N}_{kec}(T),$$

the parameters of which are defined by minimization of the functional

$$\chi^2 = \sum_{k,n} \left\{ \left[\mathcal{N}_{kn} - \mathcal{N}_{k+theor}(T_{kn}) \right]^2 / \Delta \mathcal{N}_{kn}^2 \right\} \quad (5)$$

where \mathcal{N}_{kn} , $\Delta \mathcal{N}_{kn}$ and T_{kn} correspond to a number of counts, error and kinetic energy (given by Eq.(4)) for the n -th channel of the k -th detector.

2. The information on the peak of elastic scattering recoil protons is obtained after subtraction of the background curve $\mathcal{N}_{kec}(T_{kn})$ from the experimental spectrum \mathcal{N}_{kn} (the curve parameters were determined from the earlier described minimization procedure). The relative differential cross-section data are extracted from the elastic peak after introducing the detec-

tors efficiency and radiative corrections.

Now we derive expression $\mathcal{N}_{kth\text{eol}}(T)$ describing the form of observed energy spectra of the recoil particles.

Background is caused by detection of particles arising from interaction of the electrons with carbon nuclei of the target and to a less extent from interactions of lost during the acceleration electrons with matter of the accelerator constructions.

The analysis of the background measurements has shown that background energy spectrum is well described by two exponents

$$\mathcal{N}_{\text{rec}}(T) = A_K \cdot \exp(-B_K T) + C_K \exp(-D_K T) \quad (6)$$

There are, however, discrepancies in relative behaviour of background curves for different exposures which exceed those permissible by counting statistics. We attribute these discrepancies to instability of that part of the background which is due to interaction of the lost electrons with the material of accelerator constructions.

The number of events detected in the elastic peak is represented by the expression

$$\mathcal{N}_{\text{kep}}(T) = M_K \cdot d\sigma/dT(T) \cdot [1 + \delta_K(T)] \cdot F_K(T) \quad (7)$$

where $d\sigma/dT(T)$ - elastic scattering differential cross section, $\delta_K(T)$ - radiative corrections, $F_K(T)$ - recoil protons detection efficiency, M_K - normalization factor permitting to represent the cross section in absolute units.

In one-photon approximation the differential cross section for elastic e-p scattering as a function of the recoil proton kinetic energy T can be defined by the following expression:

$$d\delta/dT(T) = \pi \left(\frac{e^2}{M} \right)^2 \frac{1}{T} \left\{ \frac{2M}{T} G_E^2 \sin^2 \theta_p + \left[(1 + \cos^2 \theta_p) \left(1 + \frac{T}{M} \right) - \left(1 + \frac{M}{E} \right) \frac{2T}{M} \right] G_M^2 \right\} \quad (8)$$

$$\cos \theta_p = (1 + M/E) T / \sqrt{2MT + T^2}$$

During the data processing it is assumed, that the electric and magnetic form factors are connected with the scaling law $G_E = G_M/\mu$ and are defined via electric radius of the proton $\langle R_{EP}^2 \rangle^{1/2}$ according to Eq.(3). Here M , μ , E and e are the mass, total magnetic moment of the proton, incident energy and charge of the electron, respectively.

The calculation procedure and the properties of $F(T)$ function describing detection efficiency of the elastic scattered proton have been discussed in detail in Ref.[9]. At calculation of $F(T)$ the geometric factors and angular change of the outgoing proton caused by the multiple Coulomb scattering in the target have been taken into account.

As can be seen from Fig.3, the efficiency curve has the form close to the smoothed trapezium, the shape and position of the lateral sides of which being defined by such parameters of the setup as the thickness of target t , the dispersion of the beam vertical density distribution δ and the detector angular coordinate θ_K . The sensitivity of the efficiency function $F(t, \delta, \theta_K, T)$ to errors of the parameters t and δ is illustrated by the lower curves of Fig.3.

Two-photon diagrams contribution, as well as bremsstrahlung depending on the geometry of the experiment are taken into account by the radiative corrections.

According to Ref. [10], the expression for the radiative corrections can be represented as follows:

$$\delta(T) = \frac{d}{dT} \left\{ \delta_{M.Y.} + \frac{E+M}{M \sin \theta_p} \int_{\theta_p + \Delta}^{\infty} \frac{d\delta(\alpha)}{d\alpha} \cdot F(t, \delta, \theta_K - \theta, T) d\theta \right\} \quad (9)$$

$$\delta_{M.Y.} = -\frac{17}{12} \ln b - \frac{7}{4} \ln \Delta a - \ln \Delta a \cdot \ln b - \frac{1}{2} \ln^2 a - \frac{139}{36} - \frac{\pi^2}{6},$$

$$\frac{d\delta(a)}{da} = \left\{ -\frac{7}{4} [(1+a)^{-1} - a^{-1}] + 2(1+a)^{-2} + \frac{3}{2}(1+a)^{-3} + \right. \\ \left. + [a^{-1} - (1+a)^{-1} - \frac{1}{2}(1+a)^{-2} - \frac{1}{2}(1+a)^{-3}] \ln \left[\frac{(1+a)^2}{ab} \right] \right\} \cos \theta,$$

$$a = \frac{E+M}{M} \cdot \frac{\sin \theta - \sin \theta_p}{\sin \theta_p}, \quad \Delta a = \frac{E+M}{M} \cdot \frac{\cos \theta_p}{\sin \theta_p} \cdot \Delta, \quad b = \frac{m_e^2}{2MT}$$

Here $\Delta = 10^{-4}$ is the angular equivalent of the energy resolution; M , T and θ_p are the mass, kinetic energy and the angle of the outgoing proton, respectively; E , m_e are the incident energy and the mass of electron; α is the fine-structure constant.

To obtain a satisfactory description of the spectra, the following varied parameters have been used in the minimized functional:

$\langle R_{Ep}^2 \rangle$ - the mean square electric radius of the proton;

M_K - the normalized factor, taking into account a relative nature of the measurements;

A_K , B_K , C_K and D_K - coefficients of background exponents, taking into account background instability;

t , ϵ , θ_K - the setup parameters determination whose accuracy is insufficient for the good description.

It should be noted, that the data on differential cross sections extracted from the experiment ^[11] performed with detection of the recoil protons in the region of momentum transfers 1 F^2 to 1.8 F^2 were used for the determination of the parameters M_K . To reduce the time needed for data processing, the efficiency and radiative corrections values have been extracted from previously tabulated functions by means of quadratic interpo-

lation. The tables were calculated for t , δ , θ_K and T intervals obviously exceeding those expected for these arguments. The table step was given to provide interpolation error lower than 0.2%. Minimization of the functional (5) was carried out by the method of linearization according to the program proposed in Ref. [12].

The considered method permits to get a good description of all measurement shifts. For typical shift presented in Fig.2, for example, the spectra have been described by $\chi^2 = 378$ at $\bar{\chi}^2 = 359$. The solid curves of Fig.2 represent the energy dependence of the fitted functions $\mathcal{N}_{K\text{theor}}(T)$. The data on relative differential cross sections $\left(\frac{d\delta}{dt}\right)_{\text{exp}}$ and corresponding radiative corrections δ obtained after the processing of this measurement shift are presented in Table 1. The errors presented in the table are statistic. The systematic errors ($\pm 0.4\%$) are due to the inaccuracy in determination of calibration curve (4) parameters and the pulse-height analyzer differential nonlinearity.

4. Results.

The total set of the data on elastic scattering differential cross sections (1350 experimental points obtained in 14 measurement shifts) has been processed in order to get an electric radius of the proton $\langle R_{EP}^2 \rangle^{1/2}$. The points of each measurement shift were provided by the normalization factor which took into account the relative nature of the measurements. Within the errors, the obtained values for the normalized factors do not differ from one. The obtained radius value $\langle R_{EP} \rangle^{1/2} = (0.83 \pm 0.03)F$ is in a good agreement with the results of other experiments, particularly, with the value $\langle R_{EP} \rangle^{1/2} = (0.84 \pm 0.02)F$ [13] obtained for small q^2 ($0.13F^{-2} \leq q^2 \leq 0.9F^{-2}$) by group from Mainz. It is interesting to note that our result agrees with

$\langle R_{EP}^2 \rangle^{1/2} = (0.817 \pm 0.009)F$ from Ref. [14], in which the experimental results on form factors for $q^2 \leq 30F^{-2}$ are analyzed by the optimal conformal transformation method.

The averaged differential cross-sections data for 49 values of momentum transfers covering $0.12F^{-2} \leq q^2 \leq 0.50F^{-2}$ interval measured in the experiment have been presented in Table 2. For this purpose the measured q^2 interval was divided into equally spaced 50 groups.

For points belonging to a particular group, the cross section $\overline{d\sigma/dT}$, error $\Delta(\overline{d\sigma/dT})$ and momentum transfers $\overline{q^2}$ averaged values have been defined as follows:

$$\overline{\frac{d\sigma}{dT}} = \left[\sum_i W_i \left(\frac{d\sigma}{dT} \right)_i \right] / \sum_i W_i, \quad (10)$$

$$\Delta\left(\overline{\frac{d\sigma}{dT}}\right)^2 = 1 / \sum_i W_i, \quad \overline{q^2} = \left[\sum_i q_i^2 W_i \right] / \sum_i W_i$$

$$W_i = 1 / \Delta\left(\frac{d\sigma}{dT}\right)_i^2$$

where $(d\sigma/dT)_i$, $\Delta(d\sigma/dT)_i$, q_i^2 are cross section, error and momentum transfer, respectively, for the i-th point of group.

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Table I.

	T_p, MeV	$\frac{d\epsilon}{dT_{exp}}$, arb. unit	$\delta, \%$		T_p, MeV	$\frac{d\epsilon}{dT_{exp}}$, arb. unit	$\delta, \%$
K = 1	4.18	953 ± 16	0.52	K = 2	6.16	432 ± 9.4	-0.37
	4.25	924 ± 15	0.40		6.23	420 ± 9.3	-0.46
	4.31	888 ± 15	0.42		6.29	409 ± 9.1	-0.55
	4.38	883 ± 15	0.37		6.35	406 ± 9.1	-0.66
	4.44	830 ± 14	0.33		6.42	389 ± 8.8	-0.77
	4.51	830 ± 14	0.30		6.48	382 ± 8.8	-0.90
	4.57	812 ± 14	0.25		6.54	363 ± 8.5	-1.02
	4.64	782 ± 14	0.20	K = 2	5.62	539 ± 11	0.67
	4.70	768 ± 13	0.15		5.68	545 ± 11	0.60
	4.77	751 ± 13	0.10		5.74	528 ± 11	0.54
	4.83	746 ± 13	0.05		5.81	522 ± 11	0.49
	4.89	711 ± 13	0.00		5.87	522 ± 11	0.45
	4.96	692 ± 13	-0.05		5.93	517 ± 11	0.42
	5.02	677 ± 12	-0.12		5.99	497 ± 10	0.39
	5.09	654 ± 12	-0.19		6.06	481 ± 10	0.35
	5.15	645 ± 12	-0.27		6.12	488 ± 10	0.32
	5.22	615 ± 12	-0.36		6.18	470 ± 9.9	0.28
	5.28	604 ± 11	-0.40		6.25	450 ± 9.7	0.25
	5.35	611 ± 12	-0.57		6.31	450 ± 9.7	0.22
	4.85	677 ± 13	0.56		6.37	452 ± 9.7	0.19
4.91	647 ± 12	0.53	6.43		445 ± 9.6	0.16	
4.97	643 ± 12	0.50	6.50		436 ± 9.5	0.13	
5.04	629 ± 12	0.46	6.56		412 ± 9.2	0.10	
5.10	637 ± 12	0.42	6.62		409 ± 9.1	0.06	
5.16	600 ± 12	0.39	6.68		413 ± 9.2	0.01	
5.22	590 ± 11	0.35	6.75		392 ± 8.9	-0.03	
5.29	577 ± 11	0.31	6.81		394 ± 8.9	-0.08	
5.35	574 ± 11	0.28	6.87	382 ± 8.8	-0.13		
5.41	555 ± 11	0.25	6.94	372 ± 8.6	-0.17		
5.47	539 ± 11	0.21	7.00	364 ± 8.5	-0.23		
5.54	529 ± 11	0.17	7.06	355 ± 8.4	-0.27		
5.60	536 ± 11	0.13	7.12	340 ± 8.1	-0.35		
5.66	525 ± 11	0.08	7.19	336 ± 8.0	-0.43		
5.73	497 ± 10	0.04	7.25	337 ± 8.0	-0.53		
5.79	498 ± 10	0.00	7.31	312 ± 7.8	-0.63		
5.85	484 ± 10	-0.05	7.37	314 ± 7.8	-0.77		
5.91	473 ± 9.9	-0.10	7.44	311 ± 7.8	-0.92		
5.98	454 ± 9.7	-0.15	7.50	315 ± 7.8	-1.10		
6.04	443 ± 9.6	-0.22	7.56	290 ± 7.4	-1.28		
6.10	460 ± 9.8	-0.29	7.63	295 ± 7.6	-1.47		

* K - number of detector.

Table 2

q^2, F^{-2}	$\frac{d\delta}{dT}, \mu\text{b}/\text{MeV}$	q^2, F^{-2}	$\frac{d\delta}{dT}, \mu\text{b}/\text{MeV}$
0.120	21.6 ± 0.26	0.315	3.10 ± 0.019
0.127	19.7 ± 0.26	0.322	2.96 ± 0.018
0.136	17.1 ± 0.12	0.331	2.83 ± 0.018
0.142	15.8 ± 0.19	0.338	2.65 ± 0.018
0.151	13.9 ± 0.11	0.346	2.54 ± 0.017
0.159	12.7 ± 0.093	0.354	2.41 ± 0.018
0.167	11.3 ± 0.067	0.362	2.31 ± 0.018
0.175	10.3 ± 0.058	0.370	2.21 ± 0.019
0.183	9.43 ± 0.050	0.377	2.10 ± 0.026
0.191	8.56 ± 0.046	0.386	2.06 ± 0.026
0.198	7.97 ± 0.042	0.391	1.99 ± 0.043
0.205	7.33 ± 0.039	0.399	1.87 ± 0.035
0.214	6.78 ± 0.035	0.407	1.88 ± 0.032
0.222	6.31 ± 0.033	0.415	1.71 ± 0.053
0.229	5.89 ± 0.030	0.425	1.69 ± 0.041
0.237	5.49 ± 0.028	0.433	1.56 ± 0.042
0.245	5.11 ± 0.027	0.443	1.50 ± 0.047
0.252	4.84 ± 0.025	0.451	1.42 ± 0.046
0.260	4.55 ± 0.024	0.463	1.35 ± 0.046
0.268	4.30 ± 0.023	0.473	1.34 ± 0.043
0.276	4.08 ± 0.021	0.479	1.29 ± 0.050
0.284	3.85 ± 0.021	0.487	1.23 ± 0.050
0.292	3.65 ± 0.020	0.498	1.17 ± 0.055
0.300	3.44 ± 0.019	0.506	1.16 ± 0.057
0.307	3.29 ± 0.018		

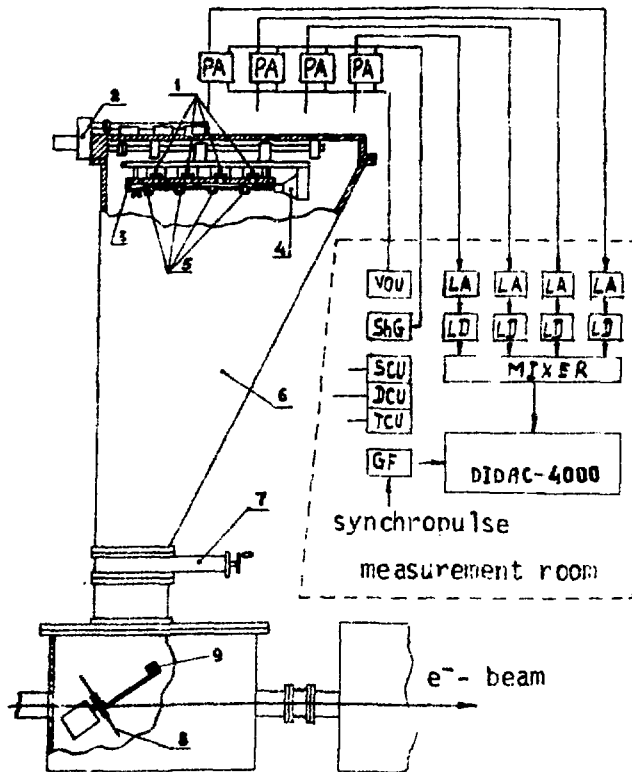


Fig.1

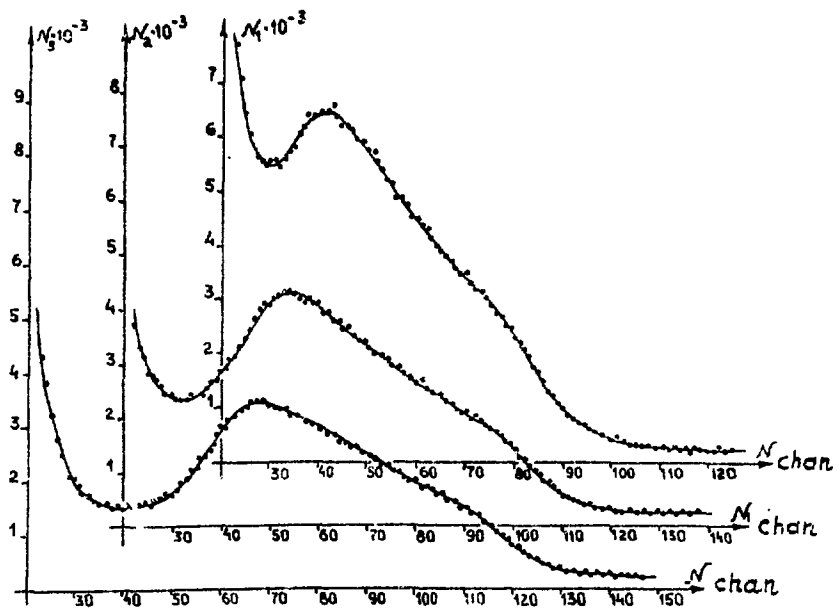


Fig.2

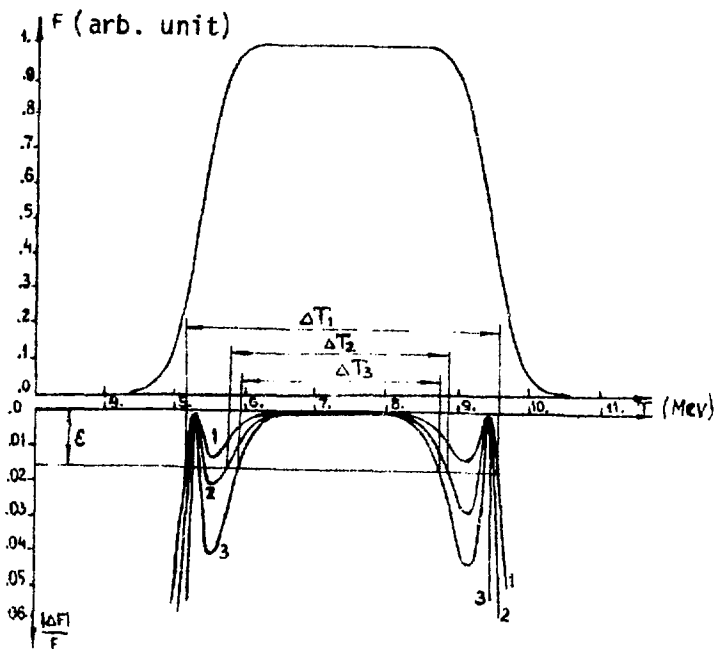


Fig.3

FIGURE CAPTIONS

Fig.1 The experimental layout.

1 - semiconductor detectors, 2 - detectors displacement unit,
3 - collimator plate, 4 - unit for remote setting of α -source,
5 - α -source, 6 - scattering chamber, 7 - vacuum gate,
8 - rotating polyethylene target, 9 - carbon target.

Fig.2 Typical spectra observed on the analyzer display during irradiation of the polyethylene target.

Solid curves represent fitted functions $\chi_{kt\lambda eoz}(T)$.

Fig.3 Efficiency F and the error in calculation of efficiency $|\Delta F|/F$ in terms of the kinetic energy T of the recoil proton.

The following errors in the target thickness t and dispersion of the beam density distribution σ correspond to these curves:

1. $\Delta t/t = \Delta\sigma/\sigma = \pm 0.05$
2. $\Delta t/t = \Delta\sigma/\sigma = \pm 0.10$
3. $\Delta t/t = \Delta\sigma/\sigma = \pm 0.15$

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ИССЛЕДОВАНИЕ УПРУТОГО РАССЕЯНИЯ ЭЛЕКТРОНОВ ПРОТОНАМИ В
ОБЛАСТИ КВАДРАТА ПЕРЕДАВАЕМЫХ ИМПУЛЬСОВ $0,12 F^{-2} + 0,5 F^{-2}$.

(на английском языке)

Ереванский физический институт

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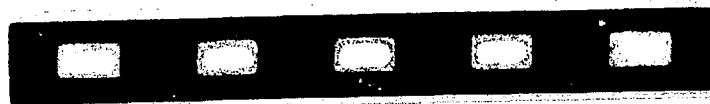
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