GENERAL CHARACTERISTICS

Actuality. The discovery of scale-invariant properties of relativistic nuclear reactions in the early 70-ies initiated intense experimental and theoretical investigations of processes with secondary particle production in the kinematical region forbidden (KFR) for scattering on nucleon in rest. According to the hypothesis on cumulative effect (CE) [1], the inclusive spectra of particles produced in KFR are universal and are independent of the geometrical properties of colliding particles, but are due to local characteristics of nuclear matter. Historically, the discovery of the phenomena of limiting fragmentation and scaling in deep inelastic eN-scattering preceded the hypotheses on CE and nuclear scaling. Transference of the scaling conceptions into the field of nuclear reactions has an important peculiarity: as distinct from elementary collisions, when scaling is theoretically achieved at asymptotic energies, the hypothesis on nuclear LF assumes scaling already at few GeV energy of incidence. Such feasibilities of experimental investigations make NLF a unique way of exploring the fundamental properties of hadronic matter expressed in the nontrivial structure of nuclei. In this respect, of a special importance are the photo- and electronuclear reactions. The advantages of these investigations owe to the essential character of interaction of electromagnetic radiation with nuclei: developed theory of QED, relatively weak interaction allowing to probe the whole volume of nucleus, etc.

In the middle of the 80-ies, the basic regularities of NS on different particle beams were experimentally stated, in particular, in investigations with incident photons with $E_\gamma > 2$ GeV on the experimental setup "Deuteron" at YerPhI. However, there was no adequate theoretical explanation of the phenomenon. There arose numerous models of particle production in KFR based on different physical conceptions, such as short-range nuclear correlations [3,4], quark bags [5], fluctons [6], final state interactions [7], etc. In virtue of the fact, that there are no unambiguous approaches to the theoretical understanding of NLF based on

simple inclusive reactions, there arises a necessity in more detailed and purposeful measurements. In this meaning, the correlation processes in electronuclear reactions stand alone, which give an additional flexibility to investigations expressed in the possibility of an independent variation of the energy and 4-momentum transferred to nucleus.

A major program of experimental investigations of nuclear matter properties at short distances in coincidence processes of electrofragmentation is adopted in YerPhI. The first results on cumulative proton electroproduction [9] measurements were

Purpose. The main goals of the thesis are:

1. Construction and analysis of operation of "Deuteron" and "Deuteron-2" setups for investigation of photo- and electrofragmentation of nuclei; simulation of the main systems and physical data processing; analysis of physical potentialities of setups.

2. Calculation of the quasideuteron mechanism's contribution into cumulative photoproton production using the results from "Deuteron".

3. Experimental investigation of deuteron photoproduction on nuclei at E_γ^{max} = 4.5 GeV and data analysis.

4. Investigation of the energy spectra of cumulative protons in coincidence with scattered electrons measured first on "Deuteron-2" based on calculations according to the short-range nucleon correlation model (SRNC).

Scientific novelty.

-In the energy range of E_γ > 1.2 GeV the first experimental investigations of the yields of deuteron photoproduction on nuclei at E_γ^{max} = 4.5 GeV have been carried out. The angular, energy and A-dependences of the yields of $A(\gamma,d)X$ reactions are obtained. The results are compared with the experimental data on processes with incident hadrons and predictions of a number of theoretical models;

-Quantitative estimations of the quasideuteron mechanism's contribution into the total process of cumulative protons photoproduction are obtained;

-The energy spectra of cumulative protons in $^{12}C(e,e'p)X$ reaction are calculated according to the model of pair correlations

of SRNC and compared with the data obtained on "Deuteron-2".

Practical Use. The constructed "Deuteron-2" setup can serve as an experimental basis for long-term physics experiments.

Analysis of the principles of operation of experimental set-ups, simulation and calibration as well as physical information readout and data processing procedures can be used in further experiments in YerPhI.

The experimental data obtained can be used for reaction yield estimations in experiments on deuteron photoproduction and in analyzing the mechanism of fast deuteron production on nuclei.

The physical potentialities of "Deuteron-2" are analyzed in model approximation in investigations of urgent problems of nearest future.

Approval. The basic material of thesis has been reported in seminars held in YerPhI, ITEP, JINR, all-Union workshops on limiting fragmentation of nuclei (Moscow (ITEP)- 1985, 1987; YerPhI (Nor-Amberd)- 1984, 1986, 1988).

Structure of thesis. The dissertation consists of an Introduction, two parts with two chapters in each, a Conclusion and References. The work is presented on 134 pages, including 47 figures, 11 tables and 88 references.

Publications. The main contents of thesis is presented in 10 publications.

CONTENTS OF THESIS

In Introduction is shown the actuality of investigations carried out, the purpose is formulated and the structure and brief contents of thesis are presented. The first part consisting of the first two chapters is devoted to the investigations of photonuclear processes. The next two chapters comprise the second part devoted to the investigations of electronuclear processes.

In Chapter 1 is described the two-arm experimental setup "Deuteron" designed for investigations of inclusive photonuclear reactions on solid targets. The beam line is described. The main characteristics of targets used are presented. The secondary particles produced in target were detected by a scintillator range

detector (RD) and a magnetic spectrometer (MS) mounted on two separate mobile platforms. The detection angles of both of the arms can be changed independently within the range from 20° to 160° with respect to the photon beam direction.

The RD is a telescope of five scintillation counters and a copper radiator of variable thickness. Particles identification in RD is performed by the (R,dE/dX) method. The solid angle is 10 msr. The range of detection of protons and charged pions energies is 80-290 MeV and 50-155 MeV, respectively.

In MS the particles are identified by a simultaneous measurement of their momentum and velocity. The momentum is measured by charged particles trajectory deflection in magnetic field with the help of two hodoscopic systems of scintillation counters. The particles velocity is determined by a time-of-flight measurement at a length of 4.5 m. The MS maximum solid angle is 1.25 msr, momentum resolution (FWHM) is 14%. The spectrometer's detecting system provides a reliable identification of pions, protons and deuterons with maximum momenta up to 1.5 GeV/c.

A detailed analysis of the principles of particles identification is performed, the main characteristics, and the results of simulation and calibration of detecting systems of the setup are presented.

Chapter 2 is devoted to the investigations of photonuclear reactions. The physical data extraction procedure and the method of calculation of correction coefficients are presented at the beginning of the chapter, also the systematic errors of measurements are estimated.

Then the quasideuteron mechanism's (QDM) contribution [8] into cumulative proton (CP) photoproduction is considered. It is stated, that for a better understanding of cumulative particle production it is necessary to determine the possible contributions from a number of models. QDM is considered as a simple mechanism providing for proton production in KFR. The obtaining of the QDM contribution is also important, because this mechanism, being trivial in the meaning of understanding of nuclear structure, however is present in experimental investigations of CP photoproduction as a physical background. Two ways of disintegra-

tion of quasideuteron pairs with a following proton P_k production in KFR are considered:

$$\begin{aligned} &a) \quad \gamma + \text{"}d\text{"} \longrightarrow n + p_k \\ &b) \quad \gamma + \text{"}N\text{"} \longrightarrow \pi + \ldots \\ &\qquad\qquad\qquad \hookrightarrow \quad \pi + \text{"}d\text{"} \longrightarrow n + p_k \end{aligned} \tag{1}$$

directly by incident photons (a) and secondary pions (b) produced in nucleus in primary γA-interaction. The calculations are carried out for carbon nucleus at $E_\gamma^{max} = 4.5$ GeV. The yield of the reaction 1a) is calculated by the numerical integration of the cross section over the bremsstrahlung spectrum of primary photons and momentum of quasideuteron pairs. The reaction 1b) is calculated by the Monte-Carlo method according to the classical intranuclear cascade scheme. The flux of secondary pions is obtained using the results of detailed experimental investigations of the $A(\gamma,\pi^{\pm})X$ reactions [10,11] carried out on "Deuteron". The results of calculations are compared with the experimental yields of $^{12}C(\gamma,p)X$ reactions [12] measured by RD. Fig.1 shows the measured energy and angular spectra of photoprotons together with the results of calculations on quasideuteron photospallation. A conclusion follows, that the contribution of QDM in this case is $\simeq$5% at $\theta_p = 90^o$, $T_p = 100$ MeV, and becomes negligible with increasing detection angle and energy of protons. The comparison of the data from [12] with the results of calculation on the reaction 1b) is shown in Fig.2. At proton energies from 80 to 100 MeV the considered mechanism's contribution into CP production can not exceed 25%. For higher energies ($\simeq$ 200 MeV) this contribution decreases down to (5-10)%.

The first experimental data on deuteron photoproduction on nuclei in the energy range of $E_\gamma > 1.2$ GeV are presented in Chapter 2. The yields of $A(\gamma,d)X$ reactions at $E_\gamma^{max} = 4.5$ GeV measured by MS of "Deuteron" are given. The angular and A-dependences of deuteron yields from C, Al, Cu, Sn, Pb nuclei at $P_d = 0.98$ GeV/c in the angular range from 30° to 120° and the energy spectra for Al nuclei at $\theta_d = 50^o$ and 90° in the momentum range $P_d = (0.84-1.25)$ GeV/c [13] are investigated.

A detailed analysis of the measured data is carried out. The

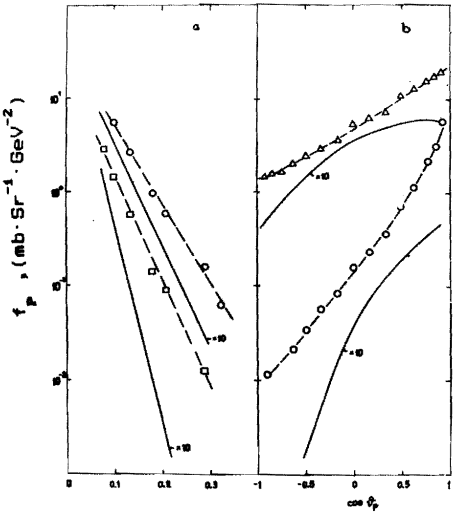

Fig.1

Proton spectra [12] from reaction $\gamma^{12}C \longrightarrow pX$ at $E_\gamma^{max} = 4.5$ GeV

a) energy spectra at $\vartheta_p = 90^o$ (○) and 160° (□)

b) angular spectra at $T_p = 100$ MeV (△) and 287 MeV (○)

Solid curves - calculations by the quasideuteron photodisintegration model.

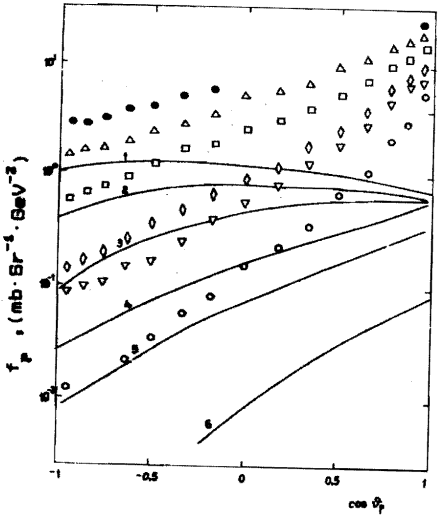

Fig. 2

Proton angular spectra [12]. The solid curves (1-6) show the results of the Monte-Carlo calculations by the model of pion absorption by the quasideuterons for proton energies 80 MeV - (●)(1), 100 MeV - (△)(2), 136 MeV - (□)(3), 180 MeV - (◊)(4), 210 Mev - (▽)(5) and 287 MeV - (○)(6) respectively.

comparison of (γ,d) and (γ,p) data reveals similarity in the qualitative behavior of the invariant spectra of these reactions (angular and A-dependences, momentum spectra). The angular dependences of the ratios of invariant yields $R \equiv f_d/f_p$ for the nuclei considered are shown in Fig.3a). Arresting is the fact, that R increases with increasing detection angle, and for heavy nuclei exceeds unity. This experimental regularity testifies against direct mechanisms of cumulative deuteron photoproduction. Indeed, in KFR as such mechanism could serve the incident photon interaction with multinucleon (≥3) intranuclear correlation with a following production of a deuteron-spectator. In the case with R > 1 this would mean an excess of correlations with order ≥3 over the ones with ≥2, which makes no sense. The same situation takes place in hadronic (h,d) processes. Further, the data are compared with the models based on indirect mechanisms of deuteron production. These are different modifications of the model of coalescence of secondary protons and neutrons produced in interactions of incident particles within nuclei [14, 4, 15, 16] and secondary pickup [17] model. The coalescence ($\varkappa_c$) and pickup ($\varkappa_p$) coefficients determined correspondingly from the relations

$$\rho_d(p) = \rho_p(p/2)\cdot\rho_n(p/2)\cdot\varkappa_c$$
$$\rho_d(T) = [\ \rho_p(T+\varepsilon) + \rho_n(T+\varepsilon)\ ]\cdot\varkappa_p \qquad (2)$$

are tabled versus A, P_d and θ_d, where ε is nucleon binding energy, ρ is invariant yield normalized to the total cross section of hadronic photoabsorption on nuclei. The experimental dependences of coefficients $\varkappa$ are closer to the coalescence models predictions [15,16].

The comparison of (γ,d) and (h,d) data reveals a great discrepancy in coalescence probability. Thus, in the cumulative region the relation of $\varkappa_c^h = (5-10)\varkappa_c^\gamma$ is valid, while the normalized yields of cumulative protons are approximately the same in both cases. This statement qualitatively agrees to the conception that unlike hadrons undergoing multiple interactions in nuclei, the photons interact only once. So, in the CP photoproduction mechanism there is a process with a suppressed yield which however is dominating in cumulative deuteron photoproduction. As such a me-

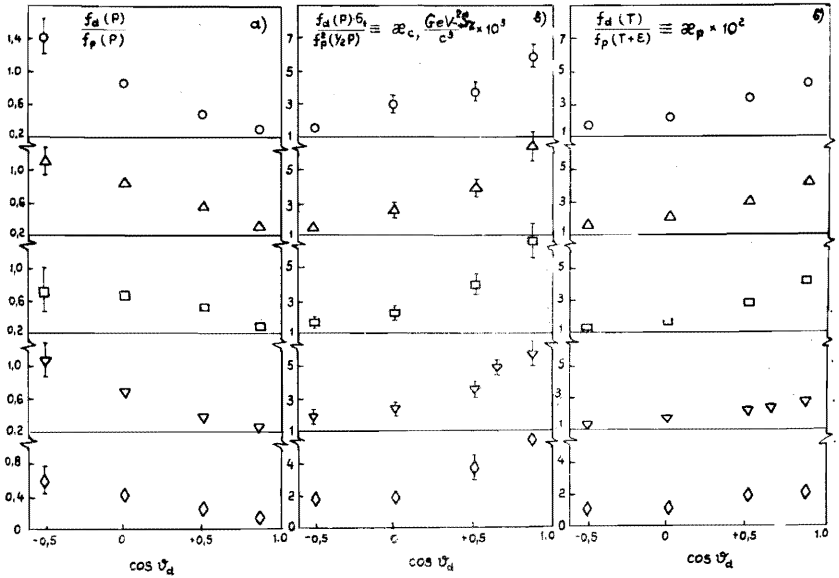

Fig. 3

The experimental dependenses of ratioes $R \equiv f_d/f_p$ (a), coalescense $\varkappa_c$ (b) and pickup $\varkappa_p$ (c) coefficients versus emission angle at P = 0.98 GeV/c and E_γ^{max} = 4.5 Gev for the nuclei: C – ◊ , Al – ▽ , Cu – □ , Sn – △ Pb – ○ .

chanism could serve the process 1b). In this approach one can qualitatively explain the $\varkappa(A,\theta_d)$-dependence, and the size of the deuteron emission region [12] is in consistence with the calculated mean free path $\lambda_\pi \simeq 2.6$ F of secondary pions in reaction 1b).

In Chapter 3 is described the two-arm experimental setup "Deuteron-2" for correlation experiments. The setup allows one to carry out investigations on either electron e^-_4 or photon "γ" beams (Fig.4).

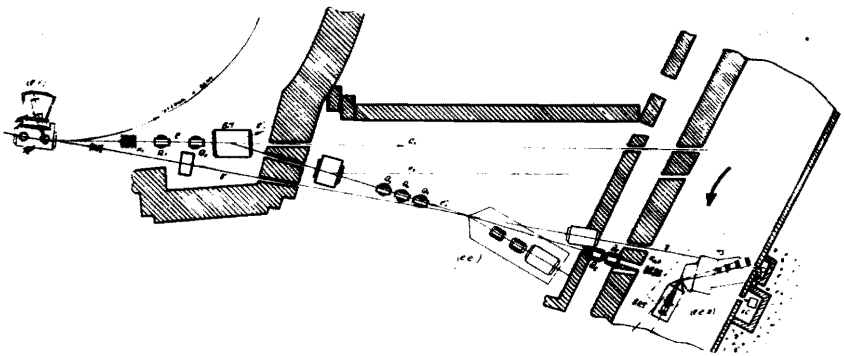

Fig.4

The setup weighing more than 60 tons is mounted on a mobile platform able to move at a distance of $\simeq$ 9 m from one beam to the other. The electron beam characteristics, especially the time ones, are analyzed. The beam-line magnetooptical system is described, and the results of calculations of beam formation are presented.

The functioning of the integral range spectrometer (IRS), i.e. proton detecting arm, is analyzed. The IRS is a scintillation counter telescope. Particles are identified using the analysis of energy deposition in a 18cm-thick plastic counter. The spectrometer's energy acceptance corresponds to the kinetic energy range from 80 to 200 MeV for protons. The solid angle is 0.1 sr. Employment of scintillation hodoscopes provides an angular resolution of $\pm 1^\circ$. The results of simulation and calibration of IRS are presented.

The magnetic spectrometer of the setup is designed for detection of charged particles with momentum up to 2.5 GeV/c. The momentum is determined by measuring the particle trajectories with the help of a system of seven multiwire proportional chambers. The π/e rejection system consisting of a gaseous threshold Cherenkov counter and a scintillator-lead shower detector is described. The results of MS simulation and calibration by measuring the electron scattering on hydrogen are presented. Chapter 3 is concluded by the description of the detection system of the setup and the system of physical information readout and processing.

Chapter 4 is devoted to the investigations of electronuclear reactions on the setup "Deuteron-2" designed mainly for investigations of nuclear matter properties at short distances using processes with hadrons in final state. The setup allows to study $(e,e'np)$ reactions with $n_s \geq 1$ at different Q^2 and ν, which do not require record energy and space resolutions. It is shown that these investigations in principle allow to study the averaged nuclear characteristics as well as certain effects in model approximations connected with the influence of nuclear medium on bound nucleon characteristics and revealing of strong pair correlations in nuclei.

A discussion of the CP energy spectra meausered first in electroproduction on "Deuteron-2" [9] is made in this chapter. The experimental data are compared with the results of calculations. Fig.5 shows the measured invariant enrgy spectra of CP from the $^{12}C(e,e'p)X$ reaction at $\theta_{ep} = 120^{o}$ (○) and 140° (△). The data are obtained by integration of the measured [9] four-differential cross section

$$f_p \equiv (1/P)d^2\sigma/d\Omega_p dE_p = (1/P)\iint\left(d^4\sigma/d\Omega_p dE_p d\Omega_e dE_e\right)d\Omega_e dE_e \qquad (3)$$

over the scattered electron variables (Q^2=(0.1-0.25) GeV^2, ν=(0-0.6) GeV) . Fig.5 shows also the calculated curves. The dashed curves show the results of calculations including both the direct and spectator mechanisms of electrodisintegration of pair correlations in rest. The cut-off of the calculated curve in the region of $T_p \simeq 160$ MeV for 140° is of a kinematic character: the corresponding scattered electron spectrum calculated according to

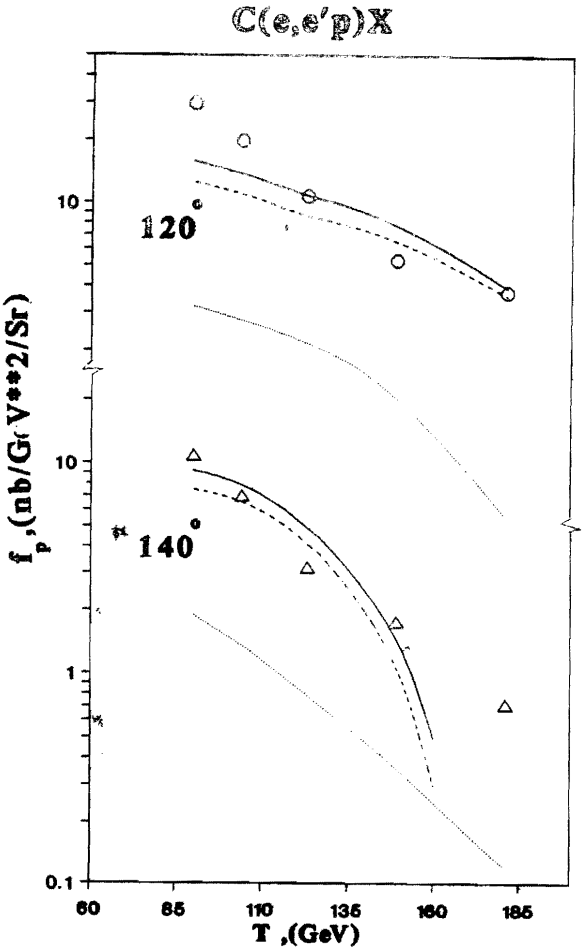

Fig. 5

The energy spectra of protons from the $^{12}C(e,e'p)X$ [9] reaction. The experimental points relate to $\theta_{ep}=120^{\circ}$ (○) and 140° (△). Solid curves show the total contributions of the pair correlation model of SRNC (dashed curves) and Δ-production (dotted ones).

the kinematics of pair correlation electrodisintegration is entirely out of the energy acceptance of MS. In the considered SRNC model the observed CP yield in this proton energy range should be explained by the contribution of higher-order correlations (triple and higher).

Two possible secondary mechanisms of CP production due to Δ-resonance production by virtual photons on Fermi nucleons are also calculated: a) absorption of pion (the product of decay of Δ) by quasideuteron pairs, and b) scattering of resonance as a whole on nucleon. The dotted curves show the total contribution of these two processes which is not essential and in the CP energy range considered makes (10-25)% for $\theta_{ep} = 120^{\circ}$ and ≃15% at 140°. The solid curves show the total CP spectra calculated according to the model of pair correlations and Δ-production. The curves follow those predicted by the SRNC model which successfully explains the CP production in coincidence with scattered electron in the experiment considered.

In Conclusion the main results of the thesis are summarized:

1. The two-arm setup "Deuteron-2" was constructed for investigations of inclusive photonuclear reactions on solid targets in the energy range up to $E_{\gamma}^{max} = 4.5$ GeV. The functioning of the main systems of the setup is simulated and analyzed. The setup is shown to provide a reliable identification of pions, protons and deuterons in a wide angular range of particle detection $\theta = 20^{\circ}-160^{\circ}$ and momenta:

-in the range detector: $P_p = 0.4-0.8$ GeV/c, $P_{\pi} = 0.1-0.25$ GeV/c with an accuracy of (1-10)% and within a solid angle of 10^{-2} sr.

-in the magnetic spectrometer: $P_{\pi} = 0.1-1.3$ GeV/c, $P_p = 0.6-1.3$ GeV/c, $P_d = 0.8-1.3$ GeV/c, with a resolution of 14% at FWHM and within a solid angle of 1.5 sr.

2. The contribution of the quasideuteron mechanism into the cumulative proton (CP) photoproduction is calculated. It is shown that in the measured CP yields

a) the contribution of quasideuteron photodisintegration on ^{12}C at $E_{\gamma}^{max} = 4.5$ GeV in the region of $p \simeq 0.4$ GeV/c and $\theta = 90^{\circ}$ does not exceed 5%. This contribution becomes negligible with in-

creasing p_p and ϑ_p;

b) the contribution of the mechanism of secondary pion absorption by quasideuteron pairs in the region of P_p = (0.4-0.5) GeV/c makes $\simeq$ 20%. This contribution decreases down to (5-10)% with P_p increasing up to 0.7 GeV/c;

3. The yields of deuteron photoproduction on C, Al, Cu, Sn, Pb nuclei at E_γ^{max} = 4.5 GeV have been measured first in the energy range of E_γ > 1.2 GeV. The angular, energy and A-dependences of invariant yields of photodeuterons are close to the analogous ones obtained in reactions with primary hadrons. The comparison of the experimental data obtained with the predictions of a number of theoretical models and hadronic data shows that:

a) the most probable mechanism of deuteron photoproduction is the coalescence mechanism;

b) comparison with hadronic data reveals a significant discrepancy in the cumulative deuterons coalescence probabilities $(\varkappa_c^h = (5-10)\varkappa_c^\gamma)$, which is believed to be due to coalescence of nucleons in the process of multiple interactions of primary hadrons in nuclei (unlike photons interacting only once).

4. The "Deuteron-2" setup is constructed for correlation investigations in photo- and electronuclear processes in the nuclear fragmentation region. The main systems of the setup are described, the results of simulation of functioning of the setup and the results of calibration of its different systems are presented.

4.1 A large acceptance integral range spectrometer is constructed on the basis of a thick (50×50×18 cm^3) scintillation counter capable to detect protons by the (E,dE/dX) method and with an energy acceptance from 80 to 200 MeV within a solid angle of 0.12 sr.

4.2 The magnetic spectrometer allows to identify scattered electrons within a momentum acceptance of $\Delta P/P$ = 46% (FWHM $\simeq$ 3 %) with $\Delta\Omega$ = 1.25 msr. The π/e rejection system based on a gaseous threshold Cherenkov counter and a lead-scintillator sandwich shower detector provides a π/e rejection better than 1% with an 80% efficiency of electron registration at $P_e \leq$ 2.5 GeV/c.

5. An extracted electron beam-line magnetooptical system is

calculated and constructed. The beam characteristics are analyzed.

6. The physical potentialities of "Deuteron-2" are analyzed in model approximation on the example of some urgent problems on investigation of nuclear matter properties at short distances.

7. The energy spectra of electroproduction of cumulative protons measured first on "Deuteron-2" at E_e = 1.94 GeV for ^{12}C are studied. Calculations according to the pair correlations model with account of the contribution of Δ-production are carried out. It is shown that the results of calculations are in a good agreement with the CP spectra measured at $\theta_{ep} = 120^{\circ}$ and 140°.

The main contents of the thesis has been presented in the following publications:

1. Alanakyan K.V., Amaryan M.J., Demirchyan R.A. et al.Setup for investigation of cumulative photoproduction of particles on nuclei\\ Preprint YerPhI-408(15)-80. Yerevan, 1980
2. Ajvazyan R.B.,Alanakyan K.V., Demirchyan R.A. et al. Magnetic spectrometer of "Deuteron" setup based on multiwire proportional chambers\\ Preprint YerPhI-493(36)-81, Yerevan, 1980.
3. Amaryan M.J., Demirchyan R.A., Egiyan K.Sh. et al. On Contri-bution of the Quasideuteron Mechanism in the Cumulative Pho-toproduction of Protons\\ Preprint YerPHI-1030(80)-87.Yerevan, 1987.
4. Alanakyan K.V., Amaryan M.J., Demirchyan R.A. et al. Deuteron photoproduction on nuclei by bremsstrahlung γ-quanta atE_{γ}^{max}=4.5 GeV\\ Preprint YerPHI-749(64)-87, Yerevan, 1987.
5. Alanakyan K.V., Amaryan M.J., Demirchyan R.A. et al. Characteristics of electron beam extracted onto the Deuteron-2" setup\\ Preprint YerPHI-1035(85)-87, Yerevan, 1987.
6. Alanakyan K.V., Amaryan M.J., Demirchyan R.A. et al. Gaseous threshold Cherenkov counter of "Deuteron-2" setup\\ Preprint YerPHI-1034(84)-87, Yerevan, 1987.
7. Alanakyan K.V., Amaryan M.J., Demirchyan R.A. et al.Integral Range Spectrometer of the "Deuteron-2" Setup\\ Preprint YerPHI-1154(31)-89, Yerevan, 1989.

8. Ajvazyan R.V.,Alanakyan K.V., Demirchyan R.A. et al.Magnetic Spectrometer of the "Deuteron-2" Setup\\Preprint YerPHI-1155(32)-89, Yerevan, 1989.
9. Amaryan M.J., Demirchyan R.A., Egiyan K.Sh. et al.The "Deuteron-2" Setup for Investigations of Electronuclear Reactions\\ Preprint YerPHI-1195(72)-89, Yerevan, 1989.
10. Alanakyan K.V., Amaryan M.J., Demirchyan R.A. et al.π/e rejection system of the "Deuteron-2" setup\\ Preprint YerPHI-1153(30), Yerevan, 1989.

REFERENCES

1. Baldin A.M. Scale invariance of hadronic collisions and possibility of obtaining of high energy particle beams at relativistic acceleration of multicharge ions\\ Brief Reports on Physics, 1971, v.1, p.35-39 (in Russian).
2. Bayukov Yu.D., Vorobev L.S., Leksin G.A. et al. Scaling effects at back scattering of protons with energies of few GeV on nuclei\\ Yad. Fiz., 1973, v.18, p.1246-1250.
3. Strickman M.I., Frankfurt L.L. Short-range pair correlations in cumulative nucleon production at high energies\\ Yad.Fiz., 1979, v.29, p.490-506.
4. Strikman M.I. and frankfurt L.L. Hard Nuclear Processes and Microscopic Nuclear Structure\\ Phys.Rep., 1988,v.160,p.236.
5. Kondratyuk L.A., Shmatikov V.Zh. Are there Multiquarks in Nuclei ?\\ Preprint ITEP-114, 27p., Moscow, 1983.
6. Burov V.V., Lukyanov V.K., Titov A.I. et al. On the mechanism of cumulative particle production in proton-nuclear collisions\\ Preprint JINR-10927, 15p., Dubna, 1977.
7. Kopeliovich V.B. Multiple processes at proton production on nuclei in the region forbidden for kinematics for (NN)-scattering\\ Pis'ma v ZhETF, 1976, v.23, p.384-392.
8. Levinger J.S. The High Energy Nuclear Photoproduction\\ Phys.Rev., 1951, v.84, p.43.
9. Alanakyan K.V., Amaryan M.J., Demirchyan R.A. et al.The (e,e'p) Reaction on ^{12}C with Backward Protons\\ Preprint

YerPHI-1303(89)-90, Yerevan,1990.

10. Alanakyan K.V., Amaryan M.J., Demirchyan R.A. et al. Angular dependence of the yield of low-energy π-mesons\\ Pis'ma v ZhETF, 1980, v.31, p.381.
11. Alanakyan K.V., Amaryan M.J., Demirchyan R.A. et al. π-meson spectra in the inclusive reaction $\gamma C \longrightarrow \pi^{\pm} X$ induced by bremsstrahlung γ-quanta with maximum energy 4.5 GeV\\ Pis'ma v ZhETF, 1980, v.32, p.666.
12. Alanakyan K.V., Amaryan M.J., Demirchyan R.A. et al.On the Angular Dependence of Photoprotons from Nuclei Irradiated with γ-Quanta with Maximum Energy 4.5 GeV\\ Nucl.Phys., 1981, v.A367, p.429.
13. Alanakyan K.V., Amaryan M.J., Demirchyan R.A. et al. Deute- ron photoproduction on nuclei by bremsstrahlung γ-quanta at E_{γ}^{max}=4.5 GeV\\ Preprint YerPHI-749(64)-87, Yerevan, 1987.
14. Butler T. and Pearson C.A. Deuterons from High-Energy Proton Bombardment of Matter\\ Phys.Rev., 1963, v.129., p.836-842.
15. Schwarzschild A. Zupancic C. Production of Tritons, Deutrons, Nucleons and Mesons by 30 GeV Protons on Al, Be and Fe Targets\\ Phys.Rev., 1963, v.129, p.854-862.
16. Mekjan A.Z. Explosive Nucleosynthesis, Equilibrium Thermodinamics and Relativistic Heavy-Ion Collisions\\ Phys.Rev.C, 1978, v.17, p.1051-1070.
17. Bayukov Yu.D., Gavrilov V.B., Gorlanov N.A. et al. Deuteron production in proton-nuclear interactions at 7.5 GeV/c\\ Preprint ITEP-123, Moscow, 1982.

ՌԱՖԱՅԵԼ ԱՐԹՈՒՐԻ ԴԵՍԻՐԱՅԱՆ

ՖՈՏՈ- ԵՎ ԷԼԵԿՏՐԱՄԻԶՈՒԿԱՑԻՆ ՌԵԱԿՑԻԱՆԵՐԻ ՈՒՍՈՒՄՆԱՍԻՐՈՒՄԸ ՄԻՆՉԵՎ 4.5 ԳԷՎ ԷՆԵՐԳԻԱՅԻ ՏԻՐՈՒՅԹՈՒՄ «ԴԵՅՏՐՈՆ» ՍԱՐՔԱԿԱՑԱՆՔԻ ՎՐԱ

Ատենախոսությունը կազմված է ներածությունից, երկուական գլուխ պարունակող երկու մասերից, վերջաբանից և գրականության ցանկից: Աշխատանքը շարադրված է 134 տպագիր էջի վրա՝ ներառյալ 47 նկար, 11 աղյուսակ և 88 անուն մեջբերված գրականության:

Աշխատանքը նվիրված է սկզբնական ֆոտոններով և էլեկտրոններով իրականացվող ատոմի միջուկի ֆրագմենտացիայի երևույթի հետազոտմանը: Բերված են նշված նպատակների համար նախատեսված ԵրՖԻ-ում ստեղծված «Դեյտրոն» և «Դեյտրոն-2» սարքավորումների նկարագրությունը, աշխատանքի վերլուծությունը, նրանց տարբեր հանգույցների մոդելավորման և ստուգաչափավորման արդյունքները: Բերված են չափման արդյունքների հիման վրա վերջնական ֆիզիկական տվյալների ստացման և մշակման արարողակարգերը:

Կոմոդյատիվ պրոտոնների ֆոտոառաջացման պրոցեսում քվազիդեյտրոնային մոդելի ներդրման հաշվարկներ են կատարված, օգտագործելով «Դեյտրոն» սարքավորման չափման արդյունքները:

Ներկայացված են $E_\gamma > 1.2$ ԳէՎ տիրույթում միջուկներից դեյտրոնների ֆոտոառաքման առաջին փորձարարական տվյալները $E_\gamma^{max} = 4.5$ ԳէՎ դեպքում: Մանրամասնորեն վերլուծված են ստացված արդյունքները, կատարելով համեմատություններ ինչպես սկզբնական հադրոններով ստացված տվյալների, այնպես էլ մի շարք տեսական մոդելների կանխատեսումների հետ:

Մոդելային մոտավորությամբ վերլուծված են «Դեյտրոն-2» սարքավորման ֆիզիկական հնարավորությունները կարճ հեռավորությունների վրա միջուկային նյութի հատկությունների ուսումնասիրման բնագավառում մոտագա ապագայի հրատապ մի քանի խնդիրների լուծման օրինակների վրա:

Վերլուծված են առաջին անգամ ԵրՖԻ-ում չափված $^{12}C(e,e'p)X$ ռեակցիայից առաջացած կոմոդյատիվ պրոտոնների էներգետիկ սպեկտրները: Փորձարարական արդյունքները համեմատված են կարճատև գործողության նուկլոնային կորելյացիաների մոդելային հաշվարկի հետ՝ հաշվի առնելով Δ-ռեզոնանսի առաջացմամբ պայմանավորված ներդրումը:

Ատենախոսության արդյունքներով հրատարակված է տասս աշխատանք:

ДЕМИРЧЯН РАФАЕЛ АРТУРОВИЧ

ИССЛЕДОВАНИЕ ФОТО- И ЭЛЕКТРОЯДЕРНЫХ РЕАКЦИЙ В ОБЛАСТИ ЭНЕРГИИ ДО 4.5 ГэВ НА УСТАНОВКЕ "ДЕЙТРОН"

Диссертация состоит из введения, двух частей по две главы в каждой, заключения и списка литературы. Работа изложена на 134 страницах машинописного текста, включая 47 рисунков, 11 таблиц и 88 наименований цитируемой литературы.

Работа посвящена исследованиям фрагментации ядер первичными фотонами и электронами. Приведены описания созданных в ЕрФИ экспериментальных установок "Дейтрон" и "Дейтрон-2", предназначенных для этих исследований. Представлены анализ принципа работ установок, результаты моделирования и калибровки отдельных систем. Приведены процедуры получения и обработки физических данных.

Выполнены расчеты вклада квазидейтронного механизма в процесс фотообразования кумулятивных протонов с использованием экспериментальных данных, полученных на установке "Дейтрон".

Представлены первые в области $E_\gamma > 1.2$ ГэВ экспериментальные данные по фотообразованию дейтронов на ядрах при $E_\gamma^{max} = 4.5$ ГэВ. Подробно анализированы полученные результаты, проведены сравнения с данными, полученными с первичными адронами и с предсказаниями ряда теоретических моделей.

В модельном приближении проанализированы физические возможности установки "Дейтрон-2" в исследованиях свойств ядерной материи на коротких расстояниях на примере некоторых актуальных задач ближайшей перспективы.

Проанализированы энергетические спектры кумулятивных протонов в реакции $^{12}C(e,e'p)X$, впервые измеренные в электророждении на установке "Дейтрон-2". Экспериментальные данные сравниваются с результатами расчетов по модели парных короткодействующих нуклонных корреляций с учетом Δ-образования.

По результатам диссертации опубликовано десять работ.

Технический редактор А.С. Абрамян

Подписано в печать 05.05.94 Формат60x84x16

Офсетная печать. Уч.изд.л. 1,5 Тираж 100 экз.

Зак. тип. 173 Индекс 3649

Отпечатано в Ереванском физическом институте

Ереван-36, ул. Братьев Алиханян 2.