JOINT INSTITUTE FOR NUCLEAR RESEARCH

PROCEEDINGS OF THE 1983 JINR-CERN SCHOOL OF PHYSICS

(Tábor, Czechoslovakia, 5-18 June 1983)

Volume I

E1,2-84-160

ТРУДЫ ШКОЛЫ ОИЯИ-ЦЕРН ПО ФИЗИКЕ 1983

(Табор, Чехословакия, 5-18 июня 1983 года)

Том I

Dubna 1984

THE JINR EXPERIMENTAL PROGRAMME IN HIGH ENERGY PHYSICS

A.N.Sissakian

Joint Institute for Nuclear Research,Dubna

One of the principal trends of the JINR scientific programme is research in high energy physics. The experiments are carried out at the Dubna synchrophasotron, Serpukhov proton synchrotron and CERN SPS.

I. In 1983 we celebrated fifteen years of collaboration with the Institute of High Energy Physics in Serpukhov. Over these years 23 large installations of the Joint Institute were used in the experiments at the Serpukhov PS /Table I/. About 40% of the Serpukhov PS performance hours are scheduled for JINR experiments. Actually experiments are carried out with the help of few "old" installations, for example, the filmless spark chamber spectrometer, relativistic ionization streamer chamber, hydrogen bubble chamber and other. New apparatus, as a neutrino detector, is under construction.

The BIS -2 filmless spark chamber spectrometer is located in the neutron beam of the Serpukhov PS of a broad range of energy from 20 to 60 GeV/c. Experiments are designed for a search of charmed particles produced in the diffraction processes/Figs.I,2/.Two modes of decay of the charmed baryon Λ_c^+ into $\bar{K}^0 p\pi^+\pi^-$ and $\Lambda^0\pi^+\pi^+\pi^-$ with a mass 2266^{+}-IO MeV were registered. The charmed baryons are produced in the reactions with $\sqrt{s}$ at IO GeV. Cross section of the Λ_c^+ inclusive production is 30 mcb per nucleon. This indicates that charmed particles are intensively produced in the almost near threshold energy region. In the same interactions the characteristics of the hyperon inclusive production with a strangeness from -I to -3 have been determined. The new baryon resonance $N\varphi \to \bar{\Sigma}(1325)K^+$ with a mass 1955 $^{+}$ 20 MeV and a width less

TABLE I: JINR EXPERIMENTS CARRIED OUT AT THE 76 GeV SERPUKHOV PROTON SYNCHROTRON */ **/

BIS Diffraction Spectrometer with proportional chambers; Angle resolution: 0.2-0.4 mrad Mass resolution: 2-5 MeV (put in op.1978)	Search for narrow baryon resonances; New baryon found $\Lambda_c \to K^0 p \pi^+ \pi^-$, $\Lambda \pi^+ \pi^+ \pi^-$ M_{Λ_c} = 2266 10 MeV; Γ_{Λ_c} = 30 MeV; σ = 1 ÷ 10 mbar per nucleon. New baryon resonance found $\Sigma^-(1325)K^+$; M_{Σ^-} = 1955 ± 20 MeV.
HYPERON Missing Mass Spectrometer Spark and proportional chambers; shower electron and gamma-quanta detectors (put in op.1978)	Study of the binary and multiparticle processes with a hypercharge exchange; leptonic pair production at 5-20 GeV; Characteristics of the reaction $\pi^+ p \to K^+ \Sigma^+ (Y^+_{1385...})$ at 12 GeV.
LUDMILA Hydrogen Chamber volume: 860 l; Track sensitive internal target of 10 l filled with liquid deuterium (put in op.1976)	Investigation of the $\bar{d}$ - d interactions
POLARIMETER Spectrometer with a "frozen" polarized proton target; proportional chambers. (put in op. 1976)	Investigation of polarized effects in the hadron-hadron collisions in a broad range of momenta transferred at the energies up to 60 GeV.
Film Streamer Chamber RISK 3 in a magnetic field (put in op.1977)	Study of the π^-, K^-p interactions with hydrogen and different nuclei at 40 GeV. Search for new charms. Investigation of the longitudinal momenta processes: $P_T > 1.5$ GeV/c.
Magnetic Spectrometer POSITRONIUM with drift chambers (put in op.1982)	Study of the reaction $\pi^0 \to \gamma + (e^+e^-)$ and positronium interaction with matter depending on the spin state.
Magnetic Spark Spectrometer MIS 2 Film data taking; proportional chambers and scintillation counter trigger system (put in op.1975)	Investigation of the bozon resonances in the dissociation processes of mesons and antiprotons on nuclei. The mass and width of the excited pion state have been determined: $M_{\pi'}$ = 1208 ± 21 MeV; $\Gamma_{\pi'}$ = 336 ± 46MeV M_{π^*} = 1770 ± 40 MeV; Γ_{π^*} = 210 ± 30 MeV.
Magnetic Spectrometer SIGMA-AJAX spark and proportional chambers (put in op.1980)	For the first time the Compton effect on π^- and K-mesons has been determined. Polarizability of the pion in the external field found; fundamental constant $\alpha_\pi = (16.8 \pm 1.4) \cdot 10^{43}$ cm^3 was determined.
NEUTRINO Detector (to be put in operation in 1984-85) Target -calorimeter; muon spectrometer; vertex detector; shower detector of e- and gamma-quanta	The cross section production, life time and decay modes of the short lived particles in the beam of muon neutrinos. Weak current structure; Deep inelastic scattering of neutrinos on nucleons.

*/ The main installations operated in 1981-83, as well as those at the stage of accomplishment, are given in Tables I,III.
**/ A number of these installations are revied in detail by D.Kiss ,see "Particles and Nuclei",1979,vol.10,3,p.552-567.

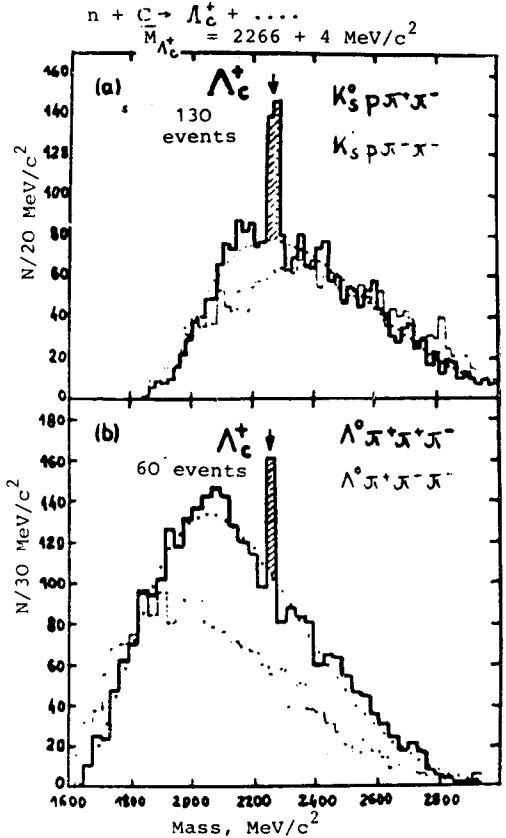

n + C → Λc+ + ...
M Λc+ = 2266 + 4 MeV/c2
(a)
Λc+
130 events
Ks0 p π+ π-
Ks p π- π-
N/20 MeV/c2
(b)
Λc+
60 events
Λ0 π+ π+ π-
Λ0 π+ π- π-
N/30 MeV/c2
1600 1800 2000 2200 2400 2600 2800
Mass, MeV/c2

Fig.I

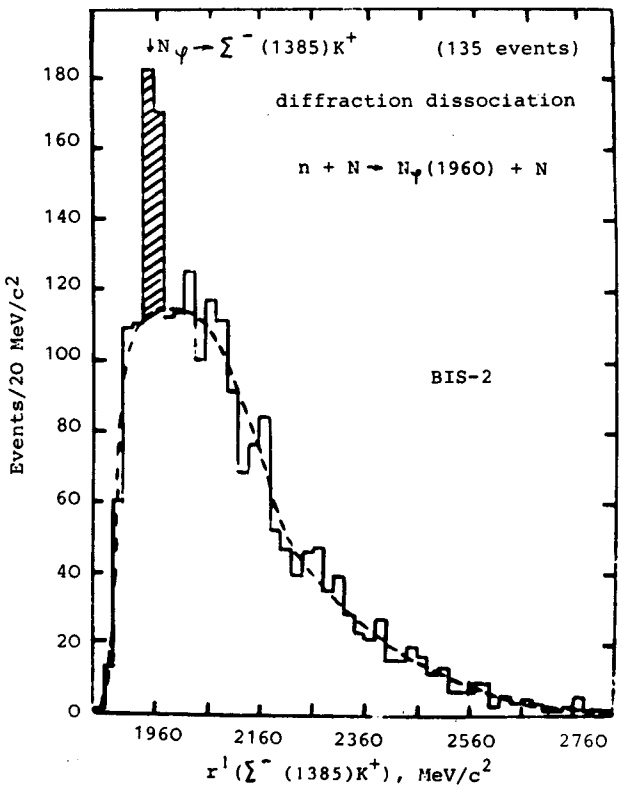

↓N φ → Σ- (1385) K+
(135 events)
diffraction dissociation
n + N → Nφ(1960) + N
BIS-2
Events/20 MeV/c2
1960 2160 2360 2560 2760
r1 (Σ- (1385) K+), MeV/c2

Fig.2

than 35 MeV was found. It may be considered as a candidate of the / uddss̄/ 5 quark state.

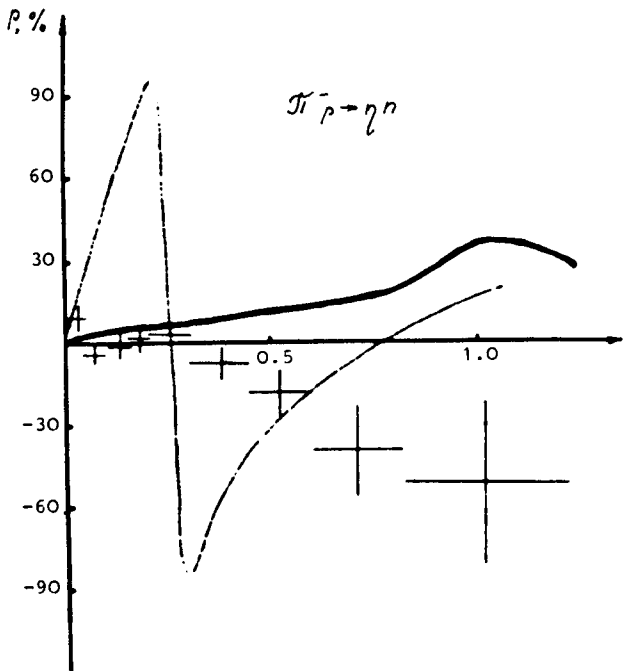
The "HYPERON" spectrometer is designed to study the binary charge exchange reactions of the pion and kaon scattering. It was found that the spectrometer had a very high resolution for secondary particles. The width of the K^{o}-meson effective mass peak is 3 MeV that is a good result obtained for such spectrometer.

The liquid hydrogen bubble chamber "LUDMILA" is used in the experiment studying the processes of multiparticle production at high energies. The chamber has a track sensitive target filled with a liquid deuterium. It was exposed in the beam of the 22.4 GeV/c antiprotons and II.5 GeV/c antideuterons. The general characteristics of the $\bar{p}p$- interactions have been determined including the peculiarities of the gamma-quanta and strange particle production. The characteristics of the baryon and meson resonances were studied among which a large alignment of ρ^{o}- and ω^{o}-mesons has been found. The big value of the ρ^{o}-meson may be explained by a confluence of polarized quarks at the stage of their junction into the meson.

Very interesting and unexpected results were obtained in the experiment on the study of polarized effects in the elastic scattering of high energy particles which was carried out with the help of the Polarimeter spectrometer the most sophisticated part of which is the "frozen" polarized proton target developed at JINR. Investigation of the polarization in pion-proton exchange scattering at 40 GeV has been performed including the eta-meson production in the reaction $\pi^{-}p \rightarrow \eta n$. A noticeable polarization $\langle p \rangle = -0.24 \pm 0.08$ was found /see Fig.3/. The results of the experiment are in contradiction with the present theoretical models and stimulate its prolongation.

The relativistic ionization streamer chamber"RISK" is an universal apparatus designed to study hadron-hadron interactions at high energies. The characteristics of the charged particle multiple production in the interaction of the 40 GeV π^{-}, K^{-}, p with hydrogen and different nuclei have been investigated in the experiment.

The physics programme of the experiment carried out with the help of the magnetic spectrometer "POSITRONIUM" provides the observation of relativistic positronii the existence of which was predicted by QED. Relativistic positronii are produced in the atomic decays of pi-zero



$\langle P \rangle = -0.24 \pm 0.08$

Fig.3

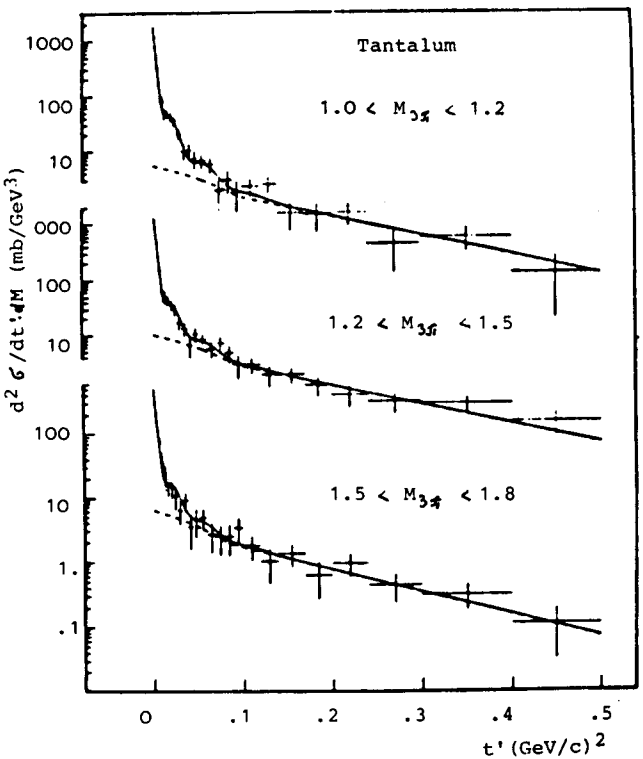


Fig.4

-mesons $\pi^0 \to \gamma + A_{2L}$ generated in the carbon target, I mcm wide, by the internal beam of the Serpukhov PS. A special channel, 40 m in length, was constructed to extract the positronii from the accelerator chamber. It has a joint vacuum system with the accelerator and is thoroughly screened from the magnetic fields. The experimental set-up is located at the end of the channel and consists of the drift chamber magnetic spectrometer. The positronium desintegrates in the magnetic field and the produced electron and positron are detected by drift chambers, 3x0.8 m in size,and scintillation and gaz counters,as well. The test data taking has been performed.

The 5 meter spark chamber spectrometer MIS was used in the joint JINR-CERN/Institute of Physics of Milan University/ experiment at Serpukhov PS. Actually data processing and analysis are continued. The diffraction production of 3 pion systems on nuclei at P_{π^-}= 40 GeV/c was investigated. Two new heavy pions with $M_{\pi'}$=I240 MeV and $M_{\pi''}$=I770 MeV have been found. They are interpreted as the radially excited states of π-mesons.

Figure 4 shows the event distribution over t' square momentum transferred. Events were selected in the diffraction cone and processed using the ASCOLI programme of the Illinois University /USA/. The analysis was made according to the partial wave method. For the 0^-S waves with quantum numbers $J^{PC}=0^{-+}$; P=-I two peaks have been found the resonance character of which can be confirmed by a relative motion of the phase, namely, waves 0^-S in the corresponding mass region /see Fig.5/.

The change of the phase indicates that these events can be considered as resonances of the heavy π -mesons interpreted by quark model, namely, by radial excitations of ud quarks.

It is supposed to proceed with a search for the A^I and A^3 meson radial excitations.

A totally new method to investigate the electromagnetic structure of light hadrons has been performed in the JINR-Serpukhov joint experiment known as SIGMA-AJAX. For the first time the elastic scattering of π- mesons on photons - the Compton effect on the pion - has been detected.

The problem of the investigation of the Compton effect on hadrons has arisen still in the fifties when in the works of A.M.Baldin et al. it was shown that the Compton effect would determine the fundamental structure constants of the particle polarizability which characterizes

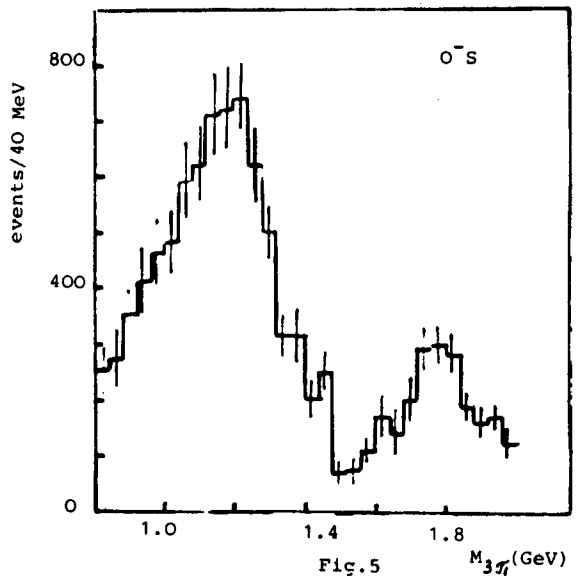
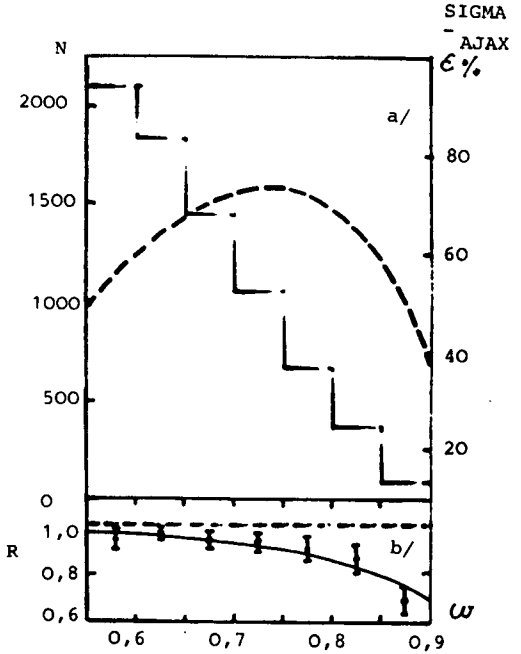


Fig.5



chiral quark theory $\sim 5 \cdot 10^{-43}$

without "quark bag" sea quarks $\sim 0{,}24 \cdot 10^{-43}$

$\sim 14 \cdot 10^{-43}$

$\sim -7 \cdot 10^{-43}$

$\sigma_{3\pi} = (6.8 \pm 1.4) \cdot 10^{-43}$ cm^2

Fig.6

particle deformation value in the external electromagnetic field. However, up to now the Compton effect was observed for the electron and proton only, and polarizability was measured only for the proton. The possibility to study the Compton effect for unstable particles, particularly, for π-mesons, was enigmatic due to the absence of the π-meson and photon targets. The idea of this experiment is grounded on the use of the Primakoff effect of the nucleus Coulomb field as a source of photons.

The experiment allows to exclude some ambiguous theoretical models and to resolve the problem of choice of the pion weak electromagnetic formfactor in the reaction $\pi \to e\nu\gamma$.

The study of the rigid gamma-quanta showed that the elastically scattered π-meson underwent a deformation which proved its composite structure /see Fig.6/. For the first time the fundamental constant has been measured which characterized the deformation of π-meson in the electromagnetic field, and the polarizability is

$$\alpha_\pi = (6.8 \pm 1.4) \cdot 10^{-43} \text{cm}^3.$$

The value obtained is very important to confirm different theoretical models describing pion quark structure and to select among them. The comparison of this value with theoretical predictions explains a necessity of taking into account the chirality principle when the polarizability is calculated. Neglecting of this principle leads to a strong contradiction with the experiment. For example, the chiral quark theory gives this value $\alpha_\pi \sim 5 \cdot 10^{-43} \text{cm}^3$; without chirality principle the value of polarizability is $-0.24 \cdot 10^{-43} \text{cm}^3$.

It was also found that composite quark models which endeavors to describe the π-meson as QUARK BAG with the dimensions of the order of the pion radius were not in agreement with the experiment. The value of polarizability $\alpha_\pi \sim 14 \cdot 10^{-43} \text{cm}^3$ predicted by these models is significantly bigger than the experimental value. The agreement can be reached provided that the significant negative contribution of the "sea" quarks $/-7\ 10^{-43} \text{cm}^3/$ would be taken into account.

A large program is concerned with the experimental confirmation of the G-S-W theory, the investigation of neutral currents in the lepton processes and the determination of the essential parameter $\text{Sin}^2\theta$ in the neutrino electron scattering. This parameter can be determined by measuring the cross sections of $\nu_\mu e$ and $\bar{\nu}_\mu e$:

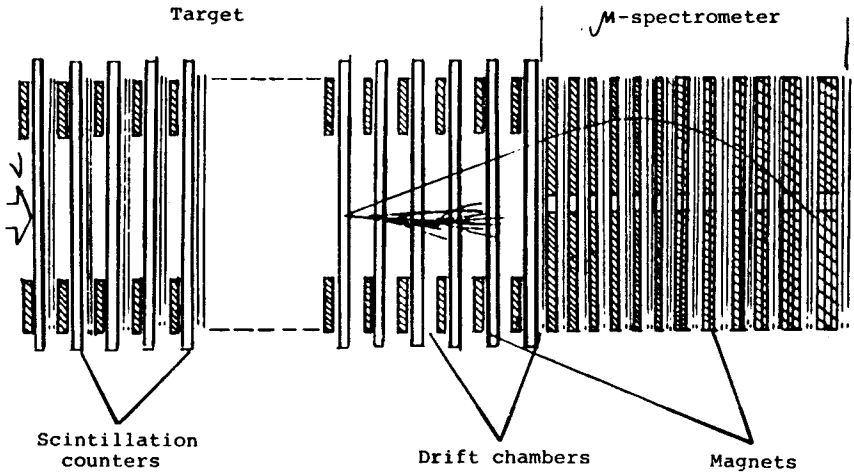

Target
μ-spectrometer
Scintillation counters
Drift chambers
Magnets

Fig.7

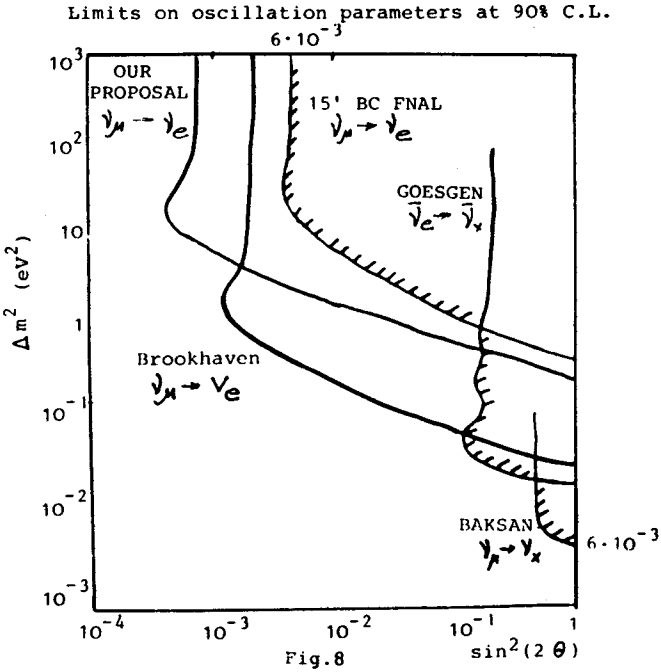

Limits on oscillation parameters at 90% C.L.
OUR PROPOSAL
15' BC FNAL
GOESGEN
Brookhaven
BAKSAN
Δm² (eV²)
sin²(2θ)

Fig.8

$$\frac{\sigma_\nu - \sigma_{\bar\nu}}{\sigma_\nu + \sigma_{\bar\nu}} = \frac{1 - 4\sin^2\theta_\mu}{2\left(8\sin^4\theta_\mu - 4\sin^2\theta_\mu + 1\right)}$$

the study of which is cumbersome due to the low level of the cross section equal to $10^{-42}cm^2$. The progress in this region will be reached with the help of the new neutrino detector constructed at JINR with collaboration of the Institute of High Energy Physics in Serpukhov and the Central Physical Institute in Zeuthen /DDR/.

The neutrino detector /see Fig.7/ consists of two essential parts: the target-calorimeter located in the magnetic field and the muon spectrometer. It is supposed to place in front of the calorimeter a vertex detector filled with emulsions and the electron-gamma-quanta shower detector at the end of the calorimeter. The neutrino detector is 34 m long, 5x5 m^2 in cross section. The total weight of the liquid scintillation target is 120 tonn. With respect to the experimental requests the target weight may be varied from 40 to 200 tonn by introducing the aluminium plates. The energy and the angle of the hadronic or electromagnetic shower produced in the interaction of the neutrino-target are measured in the calorimeter. The energy of the muon is measured at the end of the spectrometer.

The design of the spectrometer and a good spatial resolution of drift chambers provide a good accuracy of the electron trajectory measurement and a high level of the background suppression. MC calculations showed that the accuracy of the electron angle measurement was of the order 4-10 mrad, and the level of background did not exceed 5-7 percents.

The rate of data taking with 40 t of the target mass is to be 7 $\nu_\mu e$ events and 3 $\bar\nu_\mu e$ events per day. During the monthly exposure of the detector in the beam of ν_μ and $\bar\nu_\mu$ it is supposed to have about 200 $\nu_\mu e$ and 100 $\bar\nu_\mu e$ interactions that would allow to determine the value of $\sin^2\theta_W$ with a degree of $\pm$ 0.015.

The neutrino detector gives the possibility to carry out almost 10 different experiments as in the neutrino beam of the broad range, and in the special purpose beams as well.

Besides the above mentioned experiments, the neutrino detector is designed for a search of neutrino oscillations that is a fundamental matter for the cosmology. It is supposed to make a search for the neutrino oscillations the probability of which may be given by

BCDMS COLLABORATION

$\mu^+ + C \rightarrow \mu^+ + X$

ϕ 120 GeV ϕ 200 GeV ---- G - A

QCD leading order fit Λ=25 MeV

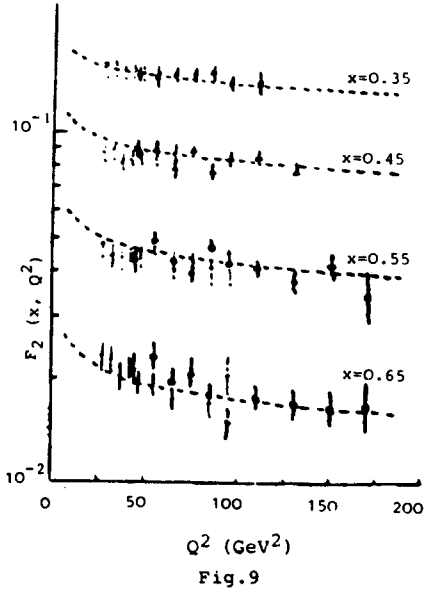


Fig.9

TABLE II: JINR JOINT EXPERIMENTS

Experiment NA-4 at the CERN SPS Toroidal high luminosity magnetic spectrometer with proportional chambers $\frac{\Delta P}{P}$ = 6%; $\frac{\Delta q_{\frac{1}{2}}^2}{q^2}$ = 7%	Study of the deep inelastic μ^+ meson interactions with matter; Study of the nucleon structure functions and electroweak asymmetries.
Experiment PS-179 at the CERN PS Streamer chamber in the magnetic field /I Tesla/ with a vertex detector	Study of the antiproton interactions with D, ^{3}He, ^{4}He, Ne in a region of 0.1 - 1 GeV/c.
JINR 5 meter magnetic spark chamber spectrometer with film data taking/MIS/ Proportional chamber trigger system.	Study of the coherent production of bozon systems by mesons on nuclei; the following properties are found: AI resonance: M_{AI}=1255 $\pm$ 23 MeV; Γ_{AI} = 292 $\pm$ 40 MeV; π' meson: $M_{\pi'}$ =1208 $\pm$ 21 MeV; $\Gamma_{\pi'}$ = 336 $\pm$ 46 MeV.
Experiment E-564 at FNAL Cryogenic sensitive nuclear emulsions inside the 15 f bubble chamber; Spatial resolution of the emulsion at t^o of the liquid hydrogen is 1 mkm.	Search for the charm decays; study of their lifetimes.
Experiment DELPHI at the CERN LEP Universal 4π spectrometer; time projection chambers; vertex detector + hadron calorimeter.	Study of the vector bozons; search for the Higgs mesons, new heavy quarks and leptons.

$$P(\nu_\mu \rightarrow \nu_e) = \frac{1}{2}\sin^2 2\theta_p\left(1-\cos 2\pi\frac{R}{L}\right),$$

where θ_p is the parameter of mixture or the Pontecorvo angle; R is the distance of the detector from the source; $L = 2.5\,\frac{p\ MeV}{\Delta m^2\ ev^2}$ is the length of oscillations.

To study the $\nu_\mu \rightarrow \nu_e$ transitions it is proposed to construct the monochromatic beam of muon neutrinos from the decay of $\pi \rightarrow \mu + \nu_\mu$ at the energy of mesons 8 GeV/c. The advantage of this energy is in the following: the admixture of $\nu_\mu(K)$ from kaon decay is 0.01; and the admixture of ν_e is 0.001. Electronic neutrinos produced in the beam of the Serpukhov PS as the result of $\nu_\mu \rightarrow \nu_e$ oscillations would be detected by means of the interaction $\nu_e + N \rightarrow e + \ldots$

The low background of ν_e from other sources allows one to make the following limitations of the oscillation parameters $\nu_\mu \rightarrow \nu_e$ with 90% confidence level of $\sin^2 2\theta_p$ at large Δm^2 and $\Delta m^2 = 0.34\ eV^2$ and the maximum mixing angle /see Fig.8/. The given result could be obtained over a monthly exposure of the neutrino detector.

2. The Joint Institute is carrying out few joint experiments coolaborating with the European Organization for Nuclear Research/CERN/ and other accelerator laboratories. The main experiments are given in Table II.

The NA-4 experiment of the Bologna-CERN-Dubna-Münich-SEN Saclay /BCDMS/ Collaboration has studied muon-quark interactions. In this experiment, the muons are scattered in a long, cylindrical target at the center of a toroidal magnet. Carbon, hydrogen, deuterium and other heavy elements are used in the target. The experiment is very complex and is concerned with many goals, particularly, with the determination of the parameter Λ that is very important for the QCD and the Standart Model unifying the weak and electromagnetic interactions. The structure functions $F_2(x,Q^2)$ and their moments as a function of transferred momentum Q^2 and Bjorken x have been studied at 120, 200, 280 GeV/see Fig.9/. In the kinematical region x=0.3-0.7 and Q^2=25-200 GeV/c^2 the small value of $\Lambda_{ms} \sim 85$ MeV has been obtained for the first time that allows to enlarge the region of the perturbation theory application in the QCD.

The asymmetry predicted by the GSW theory - the difference between the μ^+ and μ^- cross-sections at a given angle- can be observed /see Fig.10/. The value of the asymmetry B is proportional to Q^2 and is arisen from interference between electromagnetic and weak interactions

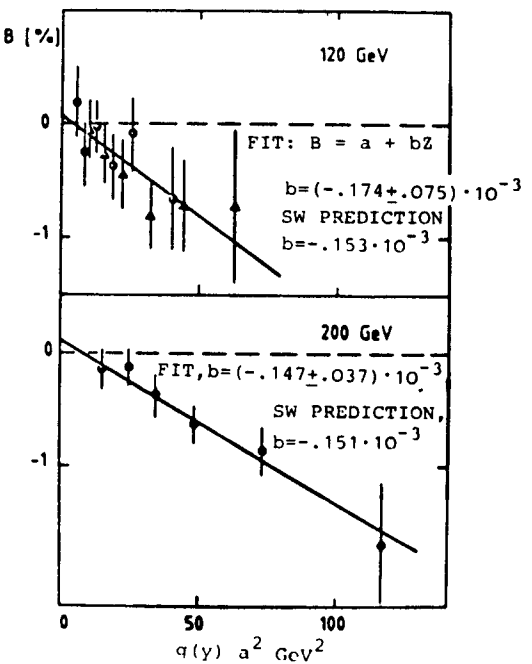

B [%]
120 GeV
FIT: B = a + bZ
b=(-.174±.075)·10⁻³
SW PREDICTION
b=-.153·10⁻³
200 GeV
FIT, b=(-.147±.037)·10⁻³
SW PREDICTION,
b=-.151·10⁻³
0
50
100
q(y) a² GeV²

Fig. 10

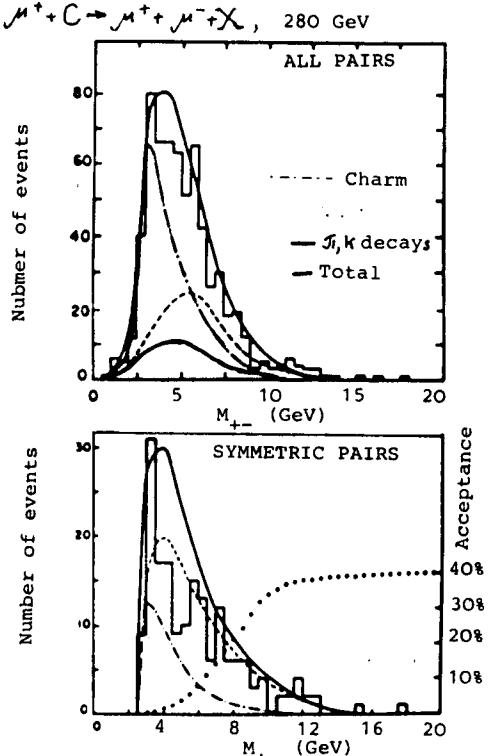

μ⁺+C→μ⁺+μ⁻+X, 280 GeV
ALL PAIRS
Charm
π, K decays
Total
Nubmer of events
M+- (GeV)
SYMMETRIC PAIRS
Number of events
Acceptance
40%
30%
20%
10%

Fig. 11

TABLE III. EXPERIMENTS CARRIED OUT AT THE IO GeV DUBNA SYNCHROPHASOTRON*

2 m propane bubble chamber Volume: 210 x 65x 43 cm^3 Magnetic field: H=15.5 ke;	Study of interactions of relativistic nuclei and neutrino with light and heavy nuclei for a search of multiquark states.
Magnetic Spectrometer ALPHA3C proportional and drift chambers; time flight and ionization hodoscope; $\frac{\Delta p}{p}$ =0,3%; $\Delta\theta$= 0.8 mrad.	Search of highly excited states of a few nucleon systems in the experiments on scattering and fragmentation of relativistic nuclei. Deuteron wave function was measured in the reaction
Recoil Particle Spectrometer semiconductor telescope; gaz identificator; scintillation magnetic spectrometer in the internal beam of the accelerator.	Study of the p, ^{3}He, ^{4}He, ^{6}He, ^{6}Li, ^{7}Li in the interaction of the 6.6 GeV protons with nuclei. Behaviour of structure functions at 6-400 GeV. Proof of the hypothesis of the nuclear scalar invariance.
DISK 3- Installation with Čerencov and scintillation counters $\frac{\Delta p}{p}$ = 6%; Time flight resolution- 1nsec	Investigation of the particle cumulative production in the relativistic nuclear physics.
130 Channel Čerenkov Mass Spectrometer	Search and study of the resonsnce production and decay into e^+e^- pairs and gamma-quanta.
Streamer Chamber RESONANCE with a liquid hydrogen target in a magnetic field	Search for 6 quark strange dibaryon systems
MASSPEAK Magnetic Spectrometer with wire chambers	Study of nuclear interactions at relativistic energies. Search for multiquark states in nuclei.
HYBRID Magnetic Spectrometer Streamer Chamber	Study of the inelastic nuclei-nuclei collisions; compression of nuclear matter; search for abnormal superdense nuclei.

*/ See Table I.

$$B = \frac{\sigma^{+}(-\lambda)-\sigma^{-}(+\lambda)}{\sigma^{+}(-\lambda)-\sigma^{-}(+\lambda)}; \quad \sigma^{\pm} \equiv \frac{d^2\sigma}{dx\,dQ^2},$$

where λ is the longitudinal muon polarization. The experiment confirmed that

at 120 GeV: $B=(0.06 \pm 0.17) + (-1.47 \pm 0.07)\, g(Y)\, Q^2$;

at 200 GeV: $B=(0.15 \pm 0.17) + (-1.47 \pm 0.37)\, g(Y)\, Q^2$.

The results are in good agreement with the predictions of the Standard Model and allowed to calculate the Weinberg angle:

$$\sin^2\theta_w = 0.23 \pm 0.07 \text{ /statistic./} \pm 0.04 \text{ /systemat./}$$

and the value of the right weak muon charge:

$$I_3^R = 0.00 \pm 0.06 \text{ /statistic./} \pm 0.04 \text{ /systemat./}$$

Thus, it was proved that the muon is a right singlet.

The mass spectrum of the $(\mu^+\mu^-)$pairs was studied in the region of 5-12 GeV /Fig.11/. This allows to determine the upper limit of the Upsilon production:

$$\sigma_\gamma \cdot B_R(\gamma \to \mu^+\mu^-) \leq 1.3 \cdot 10^{39} \text{cm}^2/\text{n}.$$

The rare events with $x_{Bj} > 1$ forbidden by usual kinematics of the muon scattering on a single nucleon at rest have been observed in 1981. /Fig.12/ The universal quark-parton structure function $F_2^c(x)$ calculated by means of these events have an exponential dependence on x_{Bj} in accordance with the prediction of the Dubna group based on ideas of the cumulative effects.

3. Few experiments are carried out at the JINR synchrophasotron using different experimental installations /see Table III/.

The 2-meter propane bubble chamber is filled with C_2H_8 propane and located in the 15.5 ke magnetic field . Few tantalum plates are placed inside the chamber; the accuracy of the momentum measurement is 5-12%. The experiment is designed to study multiparticle production and nuclear interactions.

After the exposure of the chamber in the beam of the Serpukhov PS and Dubna phasotron data have been processed and analysed. Spectra of invariant masses of particles with exotic quanta numbers were studied for narrow multiquark resonances. The values obtained are in agreement with the predictions of theoretical quark models,for example, with the MIT model.

The correlation method of measurement of the particle time-spatial production was used to select a symmetric system of the inertion center of colliding quarks or to determine the Lorentz factor of the fragmentary quark. It was turned out that in the s.c.m. of two colliding

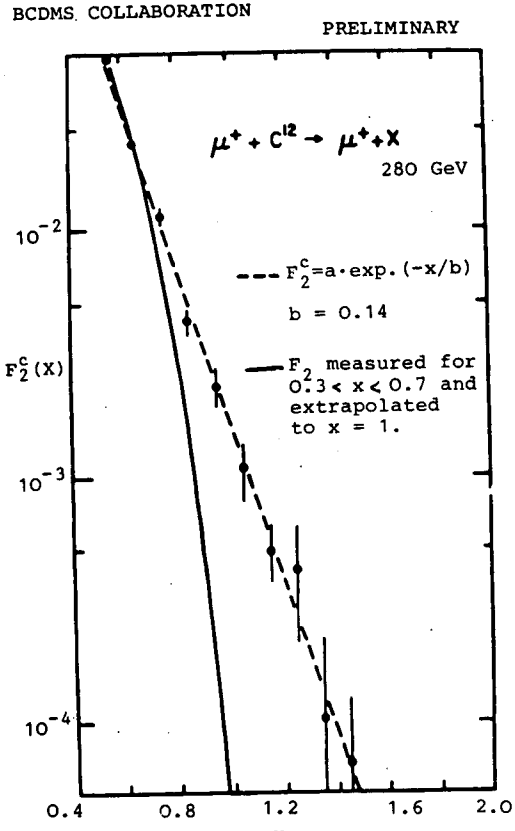


Fig.I2

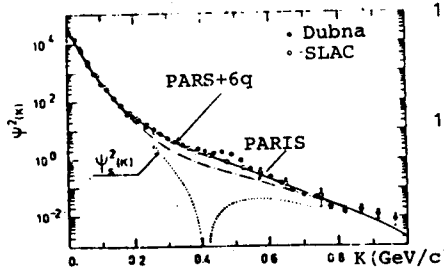


Fig.I3

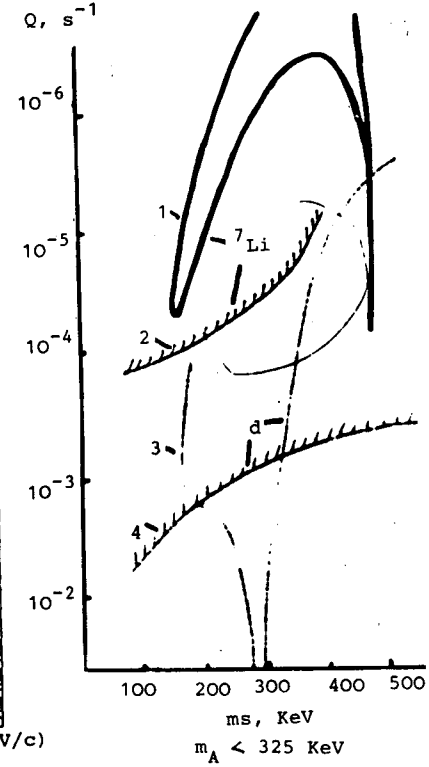


Fig.I4

quarks the longitudinal region of the pion emission had a minimum dimension. This result proves experimentally the previously proposed at JINR formula of new relativistic transformation according to which

$$\ell = \ell_0 (1 - \beta^2)^{-1/2} .$$

The ALPHA spectrometer is a filmless magnetic spectrometer to detect fast particles in the inelastic and elastic scattering of hadrons and relativistic nuclei. The momenta and angles are measured with the accuracy of 0.3% and 0.8 mrad, corresponding. In the stripping reaction $d+C \to p+X$ the deuteron wave function has been measured at momentum of 8.9 GeV/c.

In the region of large relative momenta of nucleons in the s.c.m. a big discrepance was found between the experimental value of the square wave function of the deuteron and the calculated value including the Paris potential /Fig.I3/. The comparison of data of the C and CH_2 targets allowed to exclude the Δ-isobars contributing to the intermediate state of the deuteron. This exceeding was explained by adding to the deuteron wave function of the six quark component with the following parameters: mean squared radius of the six quark state is 0.55 ± 0.05 fm; the value of the six quark admixture is 8.6 ± 0.4 %; the relative phase of the two nucleons and six quark state is $82^{\circ} \pm 6^{\circ}$.

The Recoil Particle Spectrometer is designed to register slow particles in the elastic and inelastic scattering. The gaz jet or the 0.5-I00 mkm thick film were used as targets inside the vacuum chamber of the Dubna phasotron. The beam passes more than 10^4 times across the film target producing a few thousands of good events per one cycle of the accelerator.

To detect the recoiled nuclei with the energy resolution of 40-I00 keV silicon semiconductors were used. The detection of particle and nuclei fragments was performed at the angle of 90°. The E/E method allowed to identify baryons and light nuclei in the region of medium energies with a good reliability.

The production of protons of the ^3He, ^4He, ^6He, ^6Li, ^7Li in the interactions with nuclei of Be, Cu, Sn, Au at 6.6 Gev has been studied. From the comparison of the structure functions of P-A interaction in the region of 6-400 GeV it follows that their constancy and behaviour satisfy the hypothesis of the nuclear scalar invariance.

The Electronic Spectrometer DISK 2 is the basic installation for a study of the broad cumulative production of particles which are momentum registrated with the accuracy of 6% ; the time-flight resolution is $\sim$ I nsec. Up-to now the data on cumulative production of the $\pi^{\pm}, K^{\pm}$ and $\bar{p}$ into the backward semisphere in the interactions of protons with nuclei of D, He, Al, Pb and deuterons with nuclei of Al, Cu, Pt, at 8.9 GeV/c have been analysed. In the region of cumulative numbers $X = 0.25 \div 3.4$ it was found that the longitudinal momentum distribution of quarks in the nuclei under study was identically described within the error limits by the relation

$$G(x) = \exp[-x/0.14].$$

For the nuclei with a bigger mass number A and the cumulative number $x > I$, the dependence of the cumulative particle production from A has a "volumetrical" character in the rigid processes $\sigma \sim A^1$.

4. A search for the new particle "axion" has been performed in the joint experiment /JINR- Institute of Nuclear Physics of the Moscow University/ at the new pulsed reactor IBR-2. This particle is of great interest and introduced in order to resolve the contradiction implied by the P- and CH-parity violation in the unified theory of electroweak and strong interactions. The results of different experiments are inconsistent with each other. The essential advantage of the pulsed reactor techniques is a supression of the cosmic background and natural radioactivity wich made difficult the detection of a new particle with other techniques. The reactor was operated at I MgW with a pulse duration of 230 sec and the frequency repetition of 25 Hrz.

The search for an axion was performed by means of the reaction of the supposed decay of the axion into two photons. An amount of 429 ± 21 coincidence signals was registered at the total energy of the photon emission of 5 MeV. The background measured between the intervals of the reactor pulses was equal to 429 ± 14. There were no photon pairs found in the experiment but a limitation for an axion mass was obtained: $m_A < 325$ keV. This is a proof of the absence of a standard theoretical axion in Nature /Fig.14/.

The violation of the spatial parity in the neutron p-resonances has been also studied at the IBR-30. The total cross sections of the Bromine and Cadmium III nuclei were measured in the beam of resonance neutrons polarized along and across their momentum direction in the region of energies with the p-wave resonance 0.88 eV ^{81}Br ; 4.53 eV and 6.94 eV ^{III}Cd /Figs.15 and 16/.

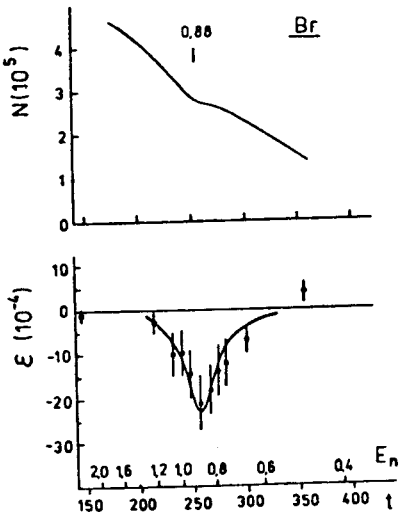


Fig.I5

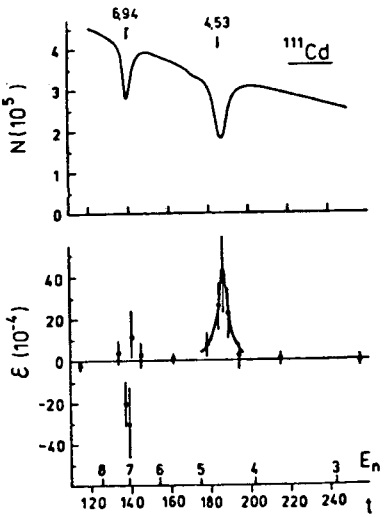


Fig.I6

From the obtained experimental spectra it is seen that the parity violation effect $\varepsilon = (N^+ - N^-) / (N^+ + N^-)$ has a resonance character similar to the usual method of transmission. Experimentally obtained matrix element of the weak interaction which violates the nuclear level parity was about I MeV for all investigated nuclei. This indicates the versatile character of the phenomenon and confirms the predicted models of the compound states.

These are the main high energy physics experiments carried out at the Joint Institute. They could be considered as preliminary work and preparation to the future experiments to be performed at the UNK in Serpukhov, at the new heavy ion accelerator complex in Dubna and at the CERN LEP.

Acknowledgement

I would like to thank Mrs.H.Savina and Mr.B.M.Starchenko for their help in preparing this manuscript.