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ON THE POSSIBILITY OF IDENTIFICATION OF PARTICLES WITH VARIOUS CHARGES IN PHOTONUCLEAR REACTIONS

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ON THE POSSIBILITY OF IDENTIFICATION OF PARTICLES* WITH VARIOUS CHARGES IN PHOTONUCLEAR REACTIONS

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Recently the processes taking place in nuclei bombarded by high energy particles, especially, the new physical phenomenon, the nuclear scaling, call great interest. One studies the deep inelastic nuclear reactions which can not be described as interaction with separate nucleons slowly moving in nucleus. The reactions with production of heavy particles ($Z \geqslant 1$) with sufficient energies emitted into backward hemisphere in laboratory frame are of especial interest [1].

In this work we describe a detector designed for detecting and identifying particles with $Z \geqslant 1$ which allows simultaneously to measure the ionization losses dE/dx , range R and emission angle of each particle as well as to determine the interaction point.

The construction of the detector is shown schematically in Fig. 1 "a". It consists of;

- a wide gap spark chamber (WGSC) for measuring the residual range R and emission angle of particle.

- a multiwire proportional chamber (MPC) the pulse of which is used for measuring the ionization losses dE/dx of particles as well as for triggering the spark chamber. The construction peculiarities and the principle of simultaneous operation of WGSC and MPC filled with $He^4 + CH_4(0.5\div5)\%$ gas mixture are given in the work [2]. The detector under investigation differs from that of the work [2] by the fact that the pulses from MPC are analyzied for measuring the ionization losses dE/dx necessary for the identification and separation of particles with $Z \geq 1$. Besides, in the volume of the detector there are several (1, 2, 3, 4 in Fig. 1 a)physical targets each of 7μ thick aluminium. The placing of these thin targets under small angle with respect to the photon beam provides a larger target effective thickness ($\sim 10^{-2} g.cm^{-2}$) along the photon beam and a smaller effective thickness ($\sim 10^{-3}$ $g.cm^{-2}$) on the path of detected particles. In order to increase the energy region of the measurements 0, 10, 20, 30μ thick mylar absorbers are placed on the path of produced particles over the targets "1", "2", "3" and "4", respectively. Gas mixture He + + CH_4(1.5%) or Ne + CH_4(1.5%) circulated through the working volume of the detector.

For the above mentioned conditions and filling gas He + + CH_4(1.5%) the detector allows to detect particles produced in photonuclear reactions in the angular interval from 60° up to 120° and in the energy region (1.5 ÷ 10) MeV for He^4 and (6÷ 30) MeV for Be^9.

After amplification and integration the pulses from MPC are given to an amplitude convertor the digital output of which are photographed together with WGSC by a stereocamera.

The calibration and tuning of MPC and WGSC have been realyzed by means of a 5.2 MeV Pu^{239} source of α-particles. Moving the source one could change the residual range of α-particles in WGSC within the limits (10 ÷140) mm. When the α-particles incident perpendicularly to the MPC plane (or when the angle of incidence is constant) the pulse height is proportional to dE/dx and, therefore, the ionization losses dE/dx depend

only on the type and energy of the detected particles provided that their range is larger than the MPC gap (16 mm). When the range in MPC is small (< 16 mm) the proportionality is violated due to the change of the dependence of ionization losses on the range. The track length in WGSC (residual range) is measured with an accuracy $\Delta R = \pm 5$ mm.

The pulse height dependence on α-particle range measured experimentally using the output pulses from MPC is given in Fig. 2a. In this figure it is also presented the curves calculated by Bethe-Bloch formula and normalized with the experimental data at one point. Fig. 2b shows the dependence of the relative errors of measured dE/dx on the range R .

The detector has been exposed to a photon beam of Yerevan Electron Synchrotron with an intensity $I_\gamma \sim 10^8$eq.γ.quanta.sec^{-1} and maximal energy E_γ^{max} =4.5 GeV. The discrimination threshold of the MPC pulses provided the detection of particles if $Z > 1$. The detector construction allowed the photon beam to pass through the working gas or through the aluminium target, the pulse frequency (loading) from MPC being ~ 2 and 3 kHz, respectively.

In Fig. 1b it is given the distribution of the interaction points of the events along the detector. The widths of the distribution correspond to the target effective thickness along the beam while the decrease of the number of the events from target "1" to the target "4" is explained by the presence of corresponding absorbers above the targets. In the region of the peaks of the distribution in Fig. 1b $\sim 85\%$ and $\sim 15\%$ of the events correspond to the particle production in aluminium target and working gas, respectively.

The experimental data on the dependence of ionization losses on residual range obtained by exposing the detector to the photon beam are presented in Fig. 3. The shaded region corresponds to the 95% confidence level that a reaction with an α-particle emission takes place taking into account the errors obtained from the results on the detector calibration. The curves of the dependence of ionization losses on residual range calculated for H^1, He^4, Li^7 and Be^9 are also given on the same figure. From the obtained experimental data it follows that by means of the above described detector it is possible to identify and separate particles with $Z \geq 2$ and to use it for the experimental investigation of nuclear reactions produced with intense photon and electron beams. The use of various gases and materials as target and absorber expands essentially the field of physical problems which can be studied by this detector.

Let us underline the most important results obtained in this work:

1. The above described detector consisted of a multiwire proportional chamber and a wide gap spark chamber and designed for detection and identification of particles with various charges $Z \geq 2$ has a simple construction and a large active area and it differs by its easy exploatation.

2. The detector allows to measure simultaneously the ionization losses, residual range and emission angle of each particle and to determine the interaction point.

3. As it is shown one can expose the detector to intense

photon beam ($I_\gamma \sim 10^8$ eq. γ-quanta. sec^{-1}) in order to study physical problems taking place in nuclei bombarded by high energy electrons and photons.

In conclusion the authors thank A.Ts.Amatuni for support and interest to the work as well as V.A.Ivanov for discussion.

FIGURE CAPTIONS

Fig. 1. a) The schematical construction of the detector.
WGSC. wide gap spark chamber;
MPC. multiwire proportional chamber;
1,2,3,4. aluminium targets.
b) The distribution of the interaction points.

Fig. 2. a) The MPC pulse height (ionization losses) dependence on the residual range. The detector is exposed to α -particles from a Pu^{239} source.
b) The dependence of the ionization losses measurement errors on the particle range.

Fig. 3. The MPC pulse height (ionization losses) dependence on the residual range. The detector is exposed to photon beam.

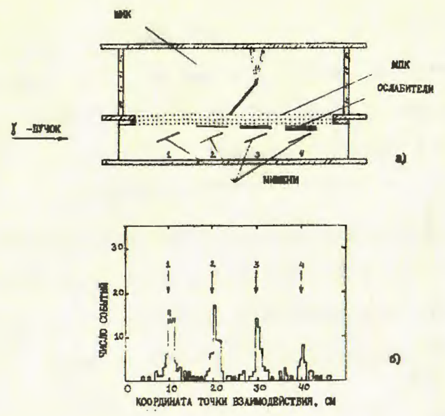

Fig. 1

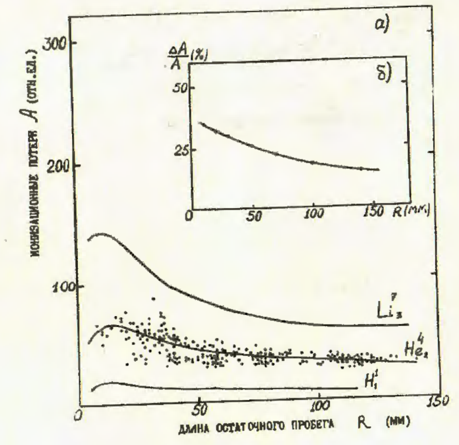

Fig.2

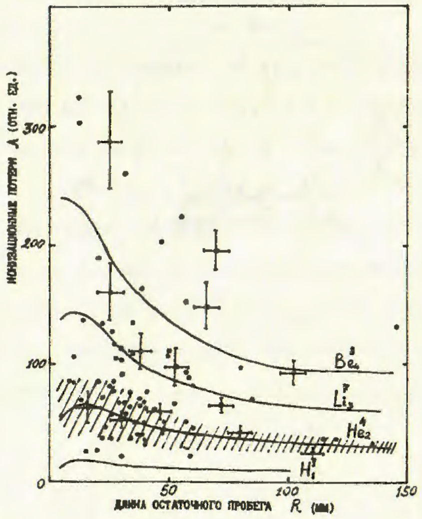

Fig. 3

REFERENCES

1. G.A.Leksin, "Proc. of the III School on Elementary Particle Physics" Institute of Experimental and Theoretical Physics, Moscow, Atomizdat, 1975 p. 15-17.

2. A.S.Alexanian, T.L.Asatiani, A.O.Gasparian, M.I.Dayon, L.A.Jirova, V.A.Ivanov, A.D.Kamenski, F.F.Kayumov, G.K. Megrabian, G.G.Mkrtchian, R.N.Pikhtelev, Scientific Report, EFI-151(75), Yerevan, 1975.

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О ВОЗМОЖНОСТИ ИДЕНТИФИКАЦИИ ЧАСТИЦ
С РАЗЛИЧНЫМИ ЗАРЯДАМИ В ФОТОЯДЕРНЫХ РЕАКЦИЯХ
(на английском языке)

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