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LOW-PRESSURE CHAMBER FOR REGISTRATION OF FISSION FRAGMENTS OF HEAVY NUCLEI

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ԾԱՆՐ ՄԻՋՈՒԿՆԵՐԻ ՏՐՈՀՄԱՆ ԲԵԿՈՐՆԵՐԸ ԳՐԱՆՑՈՂ ՑԱԾՐ ԺՆՇՄԱՆ ԽՑԻԿ ԲՆՈՒԹԱԳՐԵՐԻ ՈՒՍՈՒՄՆԱՍԻՐՈՒԹՅՈՒՆՆԵՐ

Նկարագրված է ցածր ճնշման խցիկը և բերված նրա բնութագրերի հետազոտությունների արդյունքները՝ ինչպես լաբորատոր պայմաններում, այնպես էլ էլեկտրոնային և ֆոտոնային փնջերով: Ծանր միջուկների տրոհման բեկորները գրանցելիս նախատեսվում է գործածել նման խցիկներ: Բերված են 4,5 ԳէՎ առավելագույն էներգիայի ֆոտոններով ուրանի միջուկի տրոհման ելքի և 1 ԳէՎ էլեկտրոններով նույն միջուկի էլեկտրատրոհման կտրվածքի նախնական արժեքները:

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ИССЛЕДОВАНИЕ ХАРАКТЕРИСТИК КАМЕРЫ НИЗКОГО ДАВЛЕНИЯ ДЛЯ РЕГИСТРАЦИИ ОСКОЛКОВ ДЕЛЕНИЯ ТЯЖЕЛЫХ ЯДЕР

Описана камера низкого давления и исследованы её характеристики как в лабораторных условиях, так и под фотонным и электронным пучками. Камера предназначена для регистрации осколков деления тяжелых ядер. Приведены предварительные измерения сечения фотовыхода деления урана для максимальной энергии фотонов 4,5 ГэВ и сечения электроделения урана для энергии электронов I ГэВ.

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LOW-PRESSURE CHAMBER FOR REGISTRATION OF FISSION FRAGMENTS OF HEAVY NUCLEI

A low-pressure chamber has been described and its characteristics tested under laboratory conditions as well as exposed to photon and electron beams. The chamber is intended for registration of the fission fragments of heavy nuclei. Preliminary measurements of the photofission yield of uranium for the maximal photon energy 4.5 GeV and electrofission cross section for the electron energy 1 GeV are presented.

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In order to perform measurements of the cross sections of electro- and photofission of uranium, we have constructed a detector for registration of the fission fragments (see Fig.1). The detector represents a multiwire proportional chamber operating at low pressure [1] . The uranium target was glued to the high-voltage electrode. The target was manufactured by electrochemical deposition of uranium to 20 μm thick aluminium foil. The target sizes were (28 x 28) mm^2, the uranium thickness was 1 mg/cm^2. The high--voltage electrodes were made of gilded tungsten wire, 40 μm in diameter, the neighbour wires being spaced at 1 mm. The signal plane was made of 20 μm wires, the latters being spaced at 2 mm.

The chamber was filled with hydrocarbon vapour under a pressure of some tens torr. The chamber generated fast signals with $\lesssim$ 2 nsec front and $\sim$10 nsec total duration. Fast linear amplifiers with an amplification coefficient $\sim$100 were used.

The low-pressure chambers were investigated both under lab. conditions and with the electron and photon beams.

The chamber efficiency was measured with respect to the registered heavy ragments of fission. Two identical sections of the chamber were used.

A californium radioactive source giving spontaneous fission was glued to the high-voltage plane of the first section. The number of pulses from the signal plane of the second section as well as the number of coincidences of pulses from the signal planes of the first and second sections were registered. Fig. 2a shows the dependence of the efficiency of the fission fragments registration on the voltage applied to the high-voltage planes. The efficiency of α -particle registration is measured as well (Fig. 2b). For that aim, the uranium target (U^{235}) was also used. As seen, the low-pressure chamber in the range up to 800 v is sensitive only to heavy fragments of fission, whereas at higher voltage also to α -particles, the registration of which at 950 v occurs already with the efficiency close to 100 %.

The chamber operation with various fillings and pressures of vapours is investigated. Fig. 3 presents the number of registered α -particles versus voltage for heptane, hexane and methylal vapours at the pressure from 14 to 40 torr. One can see no noticeable difference between the results in the plateau region of α -particle registration.

The study of the chamber behavior for various pressures of heptane vapours at the registration of heavy fragments of uranium photofission was carried out under the photon beam with maximal energy of photons 4.5 GeV. The photon beam intensity was (10^8-10^9) photons/sec, the monitoring was realized with a quantometer. The measurements were taken in that region of voltage where the chamber was not yet sensitive to the α -particles. Fig.4 presents the dependence of the registration efficiency of U^{235} photofission fragments in relative units upon high-voltage applied to the chamber at different pressures of heptane vapours. In the plateau region the registration efficiency of the fission fragments is independent of the choice of the working gas pressure in the chamber.

The analogous investigation was carried out using the electron beam. Fig.5 shows the dependence of the registration efficiency of the electrofission fragments in relative units on the high voltage applied to the chamber filled with heptane vapours under the pressure of 14 torr. The electron beam energy was 1.5 GeV, the duty factor ~1 %. The dependence of counting characteristics of the chamber on the beam intensity is studied. The "plateau" on the counting characteristic vanishes with increasing the beam intensity. Fig. 6 presents the electron beam intensity dependence of the chamber counting normalized per number of passed electrons under the regime of registration of uranium fission fragments. One can see that in the intensity range up to $3 \cdot 10^7$ e/sec the chamber operation is sufficiently stable.

Taking the chamber geometric efficiency 100 %, the preliminary measurements of the cross section for electrofission with the energy 1 GeV and intensity $\approx 10^7$ e/sec as well as for photofission with the photon maximal energy E = 4.5 GeV were carried out. The chamber was filled with the hentane vapours under the pressure of 14 torr. The background due to natural alpha radioactivity of the target was also taken into account. The background made up (1-10) % of electrofission and (0-1) % of photofission cases, respectively. In the determination of cross sections the background was subtracted. The obtained values of the cross sections σ_{ef} = (11.54±0.26) mb and $\sigma_{\gamma f}$ = 382.2 mb agree well with the values available in the literature [2,3] . For electrofission the error is statistic, while for photofission it is practically absent. The systematical errors due to monitoring of electron and photon beams make up $\leq$ 10 %. However, such estimation of the cross sections is sufficient to show the applicability of the low-pressure chamber in electro- and photofission coincidence experiments.

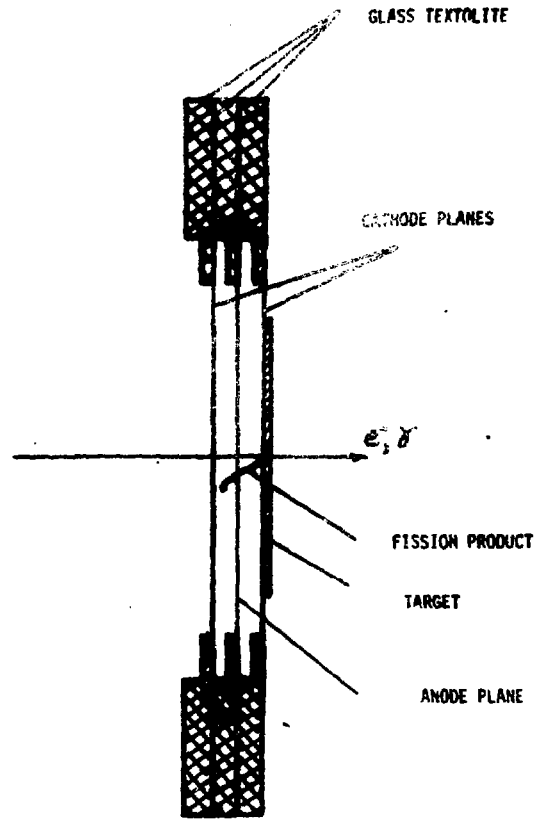

Fig.1. A schematical diagram of the low-pressure chamber.

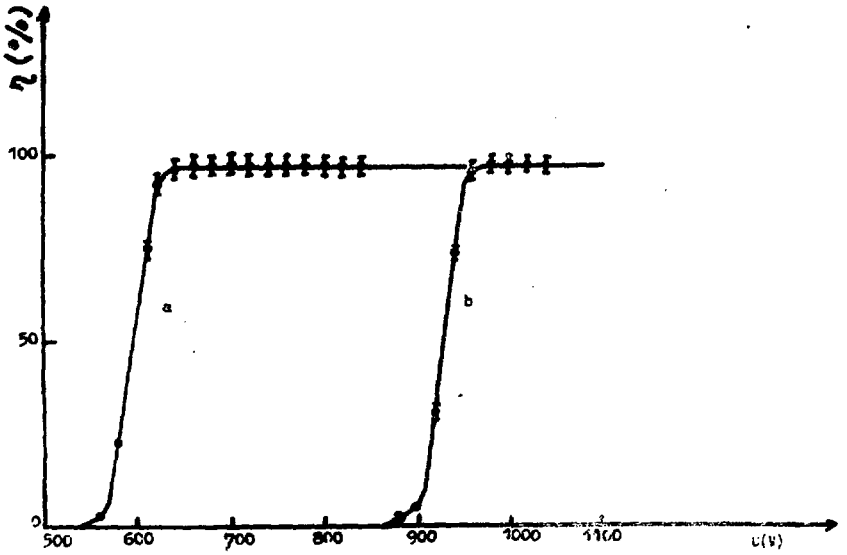

Fig.2. The efficiency of the low-pressure chamber as a function of the applied voltage.

a) - the registration region of the fission fragments;

b) - the registration region of α -particles.

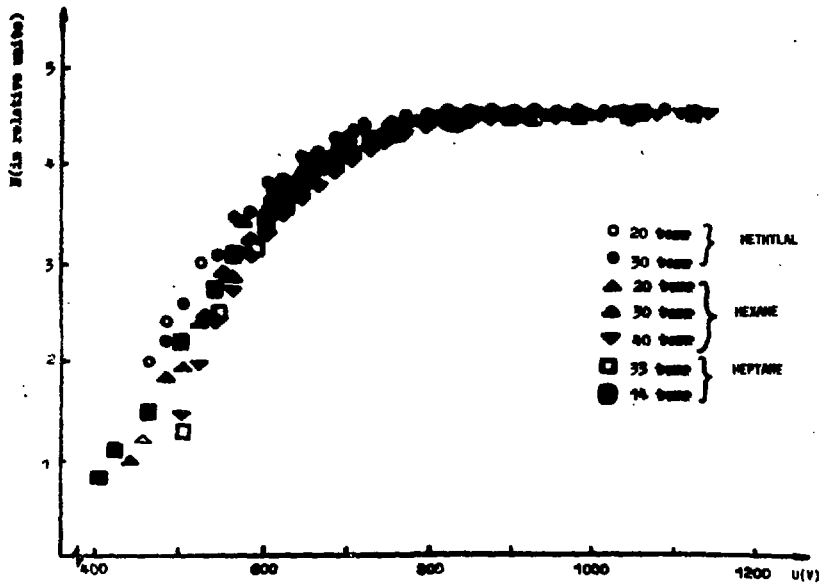

Fig.3. The dependence of the counting rate of α -particles on the chamber voltage for the heptane, hexane and methylal vapours at the pressures of 14-40 torr.

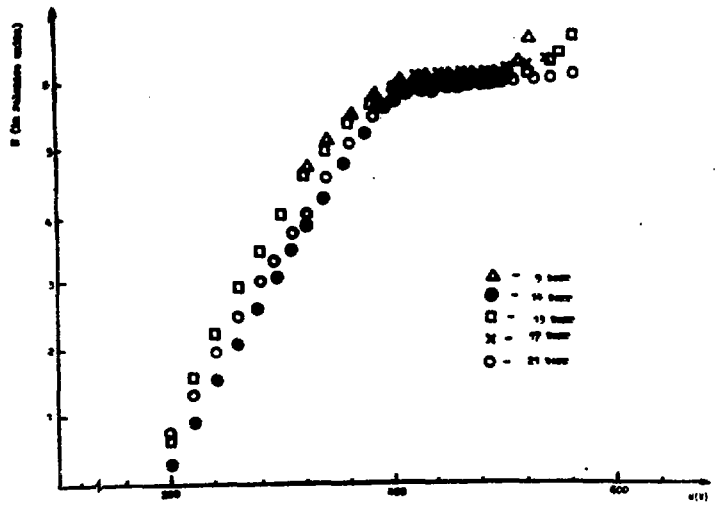

Fig.4. The dependence of the registration efficiency of the U^{235} fission fragments in relative units on the chamber voltage, under the photon beam with the photon maximal energy 4.5 GeV.

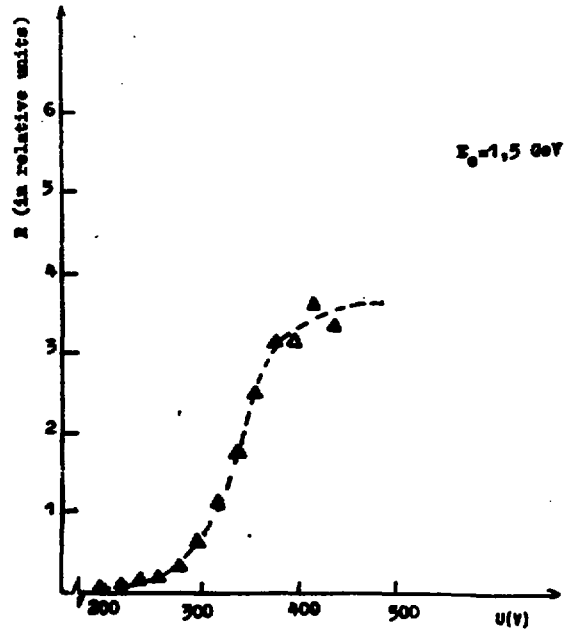

Fig.5. The dependence of the registration efficiency of the U^{235} fission fragments in relative units on the chamber voltage obtained under the 1.5 GeV electron beam.

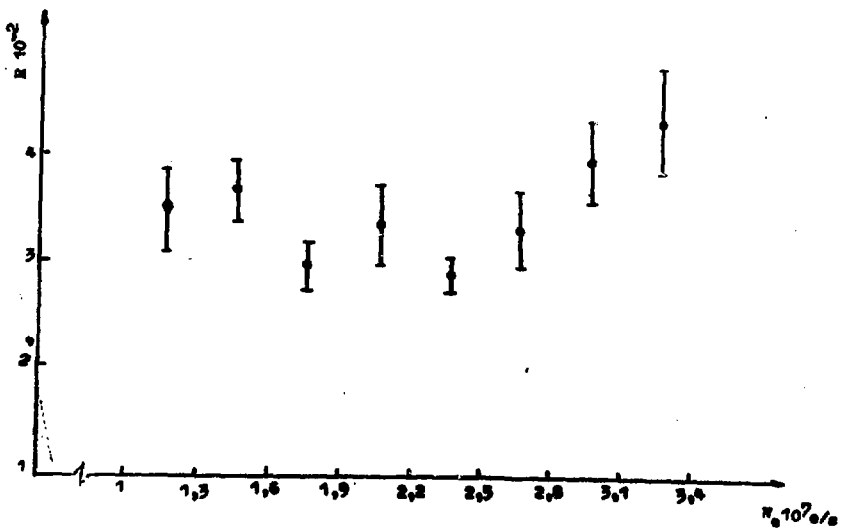

Fig.6. The dependence of the ratio of the chamber counting rate to the number of passed electrons in relative units upon the electron beam intensity.

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