Collision of an electron with a positive molecular ion produces a neutral molecule in a highly-excited Rydberg state; this molecule decays either by auto-ionization or by dissociation into neutral atoms. In an electric field, the rate of decay with formation of a free electron increases, and the rate of the competing dissociative-decay process decreases correspondingly. This picture agrees qualitatively with the arguments advanced in [10] in a description of predissociation in an electric field.

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ASYMMETRY OF THE CROSS SECTION OF THE REACTION $\gamma d \to \pi^0 d$ AT A PHOTON ENERGY 350 MeV

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Investigation of the coherent photoproduction of π^0 mesons on deuterium yields valuable information both on the deuteron structure and on the isotropic structure of the pion photoproduction amplitudes on nucleons.

Only a limited number of studies have been made of the differential cross sections of the reaction $\gamma d \to \pi^0 d$ in the region of the first πN resonance [1 - 3]. Data on the cross-section asymmetry due to polarized photons in this reaction are practically nonexistent [4, 5].

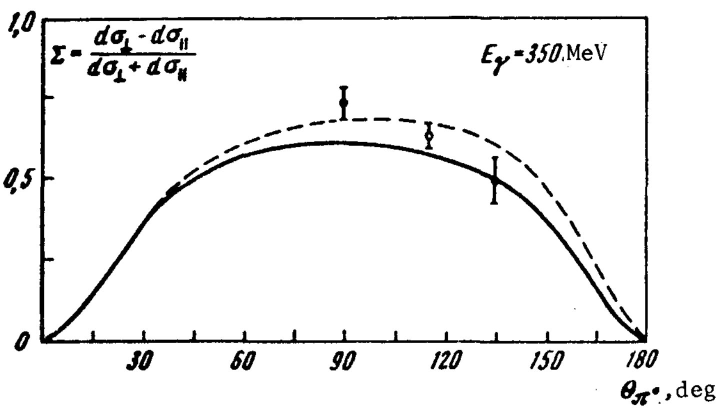

Fig. 1. Angular distribution of the asymmetry of the cross section of the reaction $\gamma d \to \pi^0 d$ at photon energy 350 MeV: • — our data, o — data of [4]. Dashed line — calculation on the basis of the BDW analysis [12] with allowance for the S wave; solid — with allowance for S + D waves.

The study of the asymmetry of the cross section of the reaction $\gamma d \to \pi^0 d$ reaction with polarized photons is of particular interest, since it does not depend on the form factor of the deuteron and on the interaction in the final state, and can yield additional information for a multipole analysis of pion photoproduction on individual nucleons.

We report here, for the first time, results of the measurement of the asymmetry of the cross section of the reaction $\gamma d \to \pi^0 d$ by polarized photons of energy 350 MeV, in which the pion is emitted in c.m.s. angles 90 and 135°, and results of a calculation of the angular distributions of the cross-section asymmetry in the photon energy range 180 — 800 MeV, in the S and S + D wave approximation.

The experiment was performed with a beam of linearly-polarized photons [6] obtained from coherent bremsstrahlung of electrons in a diamond single crystal.

After being momentum-analyzed in magnetic spectrometers [7], in the foci of which the liquid-hydrogen - deuterium target [8] was placed, the deuterone were detected with a telescope of scintillation counters and were distinguished from the protons by pulse-height analysis.

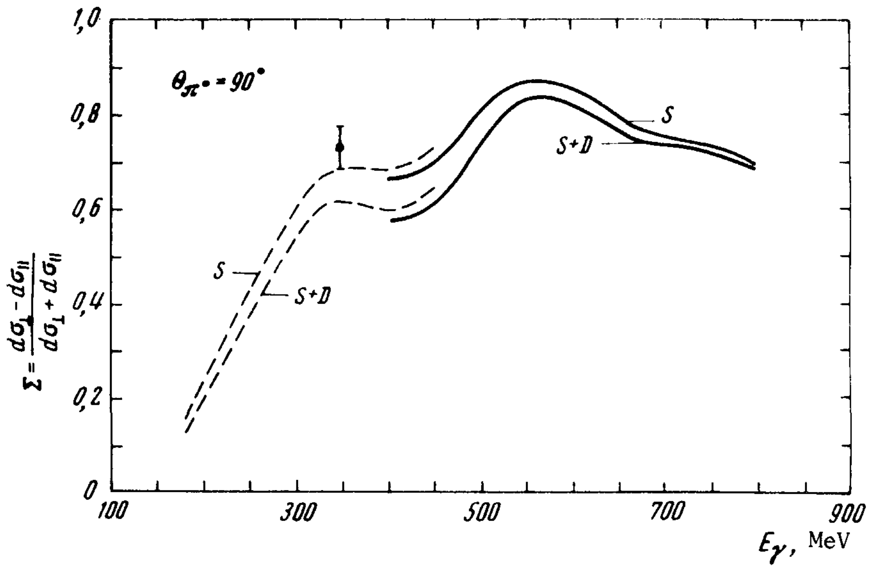

Fig. 2. Asymmetry of the cross section of the reaction $\gamma d \to \pi^0 d$ vs. the photon energy for a pion emission angle 90° in the c.m.s.: o — our data. Dashed curves — calculated on the basis of the BDW analysis [12], solid curves — on the basis of Walker's analysis.

The procedure for measuring the asymmetry

$$\Sigma = \frac{d\sigma_\perp - d\sigma_\parallel}{d\sigma_\perp + d\sigma_\parallel} = \frac{1}{\bar{P}} \frac{R - 1}{R + 1},$$

where $d\sigma_\perp$ ($d\sigma_\parallel$) is the cross section for pion production by photons with a polarization vector perpendicular (parallel to the reaction plane, $\bar{P}$ is the effective photon polarization, and R is an experimentally measured quantity analogous to that described in [9, 10].

E_γ, MeV	$\Theta^*_{\pi^0}$, deg	R	$\bar{P}$	$\Sigma = \frac{d\sigma_\perp - d\sigma_\parallel}{d\sigma_\perp + d\sigma_\parallel}$
350	90	1.854	0.41	0.730 ± 0.045
	135	1.505	0.41	0.487 ± 0.072

The results of the asymmetry measurements are given in the table and are compared in Figs. 1 and 2, with the theoretical relations calculated in the impulse approximation with allowance for the S and S + D waves, using the formalism of [1].

Calculations of the angular distributions of the asymmetry in the region of the first πN resonance ($E\gamma$ = 180 - 450 MeV) were performed using the multipole amplitudes of the BDW analysis [12], and in the region of the second resonance ($E\gamma$ = 400 - 800 MeV) we used the results of Walker's phenomenological multipole analysis [13].

The agreement between the experimental and calculated data is satisfactory.

The authors thank M. P. Rekalo and V. F. Boldyshev for constant interest and a discussion of the results.

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METHOD OF MEASURING LOCAL PLASMA PARAMETERS WITH THE AID OF A BEAM OF FAST ATOMS

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A method is described for measuring the ion distribution function in a small fraction of the plasma volume, and of measuring the spatial profile of the plasma density by means of the atoms produced by charge exchange of the plasma ions with the fast atoms of the diagnostic beam. Results of measurements in an open trap with crossed E and H fields are presented.

The procedure for measuring the ion distribution function f(E) in a plasma by using the atoms resulting from charge exchange of the ions by residual gas [1] has many shortcomings in the case of a sufficiently dense, hot, and long-lived plasma. First, the function f(E) is averaged in the measurement over the plasma volume along the observation direction. Second, the charge-exchange target, the role of which is played by the residual gas, can be appreciably inhomogeneous in space and in composition. Indeed, in a plasma with concentration $n \gtrsim 10^{12}$ cm^{-3} and an electron temperature $T \gtrsim 20$ eV the mean free paths for ionization of the neutral atoms of the residual gas are much shorter than the characteristic plasma dimensions. In a hot plasma region, the target density n_0 can therefore be much lower than in the regions next to the walls, where the plasma is cold. In addition, at the considered plasma parameters, the gas atoms can be excited by electrons, and the dependence of the cross section σ_{10} for charge exchange with the excited atoms on the ion energy is usually unknown. Finally, a noticeable role can be played in the charge-exchange exchange process by impurity ions and atoms that enter the plasma from the walls. These shortcomings can be eliminated by using as the target a fast beam of neutral atoms [5] with velocity v_0 much larger than the thermal velocity v_T of the plasma ions. At an atom concentration in the beam

$$n_1 = n_0 \frac{<\sigma_{10}(v_i)v_i>}{<\sigma_{10}(|v_i + v_0|)|v_i + v_0|>} \frac{L}{\ell} \tag{1}$$

the fluxes of the ions experiencing charge exchange with the beam and with the residual gas already become comparable (here L and ℓ are the dimensions of the plasma and beam, respectively, along the observation direction and v_i is the ion velocity). By choosing optimal values of v_0 and ℓ, and also by using electronic methods to separate the signal from the noise (for example, by modulating the beam current), it is possible to make the required ratio n_1/n_0 quite small, $\sim 10^{-2} - 10^{-4}$.

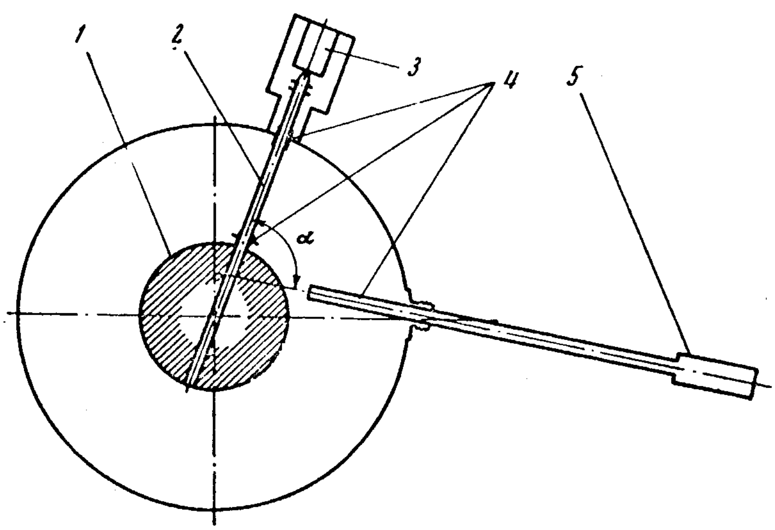

Fig. 1. 1) liner confining the plasma, 2) beam of hydrogen atoms, 3) arc source [3], 4) beam and analyzer collimators, 5) analyzer.

The effectiveness of the proposed procedure was verified in measurements in a rotating plasma in a probkotron mirror machine [2]. A pulsed beam (200 μsec) of hydrogen atoms of energy 15 keV, equivalent current 300 mA, and 3 cm diameter was introduced perpendicular to the