matter with transfer of an energy & $\gtrsim$ 10 - 20 eV to the electron in each interaction act.

In conclusion, we thank A. I. Afonin for help with the experiment.

[1] A lower cross section limit was obtained in [9] by using a tritium source. This limit is not considered here, in view of the much lower antineutrino energies.

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MECHANISMS OF NEUTRON GENERATION IN A LASER PLASMA

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The mechanisms whereby neutrons are generated in a plasma are discussed on the basis of the experimental data for different heating regimes. It is established that in the case of sharp focusing of the radiation (10 - 20 GW power and 2 nsec duration) the bulk of the neutron yield is due to gasdynamic acceleration of the expanding plasma, and is nonthermal in character. In the case of spherical irradiation (power 300 GW, duration 1.5 nsec), the neutrons produced in a dense CD_2 plasma (10^7/pulse) are thermal.

1. Various mechanisms of nonlinear interaction between high-power laser radiation and a dense plasma and the possible particle-acceleration mechanisms, which may in particular be the cause of neutron generation in a laser plasma, have been under discussion of late [1 - 3]. We present here results that allow us to state that, depending on the conditions, both thermal and nonthermal neutrons are produced in experiments with laser plasma. The measurements were performed both with sharp focusing of the emission of a single-channel laser on a massive CD_2 target and with spherically-symmetrical irradiation of a CD_2 particle of $\sim$ 100 μ diameter by emission from a multichannel laser setup [5].

2. Sharp focusing on a massive target. The laser power was 10 GW, the light pulse duration 2 nsec, and the neutron yield 10^4 neut/pulse. Oscillograms of the neutron pulses obtained with the scintillation detector placed $\sim$ 10 cm from the target, are shown in Fig. 1. The neutron pulse delay relative to the instant of plasma heating greatly exceeds the $\sim$ 5 nsec neutron flight time, and a second neutron pulse of smaller amplitude appears after 40 nsec. When a screen of CD_2 is placed inside the chamber, the delay time decreases and an increase in the signal amplitude is observed (Fig. 1b). This allows us to conclude that in the case of sharp focusing the neutrons are produced as a result of the beam deuterons emitted from the plasma with the deuterium absorbed either on the chamber walls or in the screen.

Two successive neutron pulses obviously correspond to different deuteron groups accelerated to different velocities. Recognizing that there is no direct neutron generation in the plasma itself, we can assume that the deuterons are accelerated mainly outside the dense core of the plasma, in a rarefied envelope. The slower deuterons with energy $E_d \sim 5$ - 10 keV are in all probability due to gasdynamic expansion of the plasma [6]. With respect to the fast deuterons ($E_d \sim 40$ keV), it can be assumed that they are accelerated by the electric field produced by emission of the high-energy electrons responsible for the hard x-rays [4].

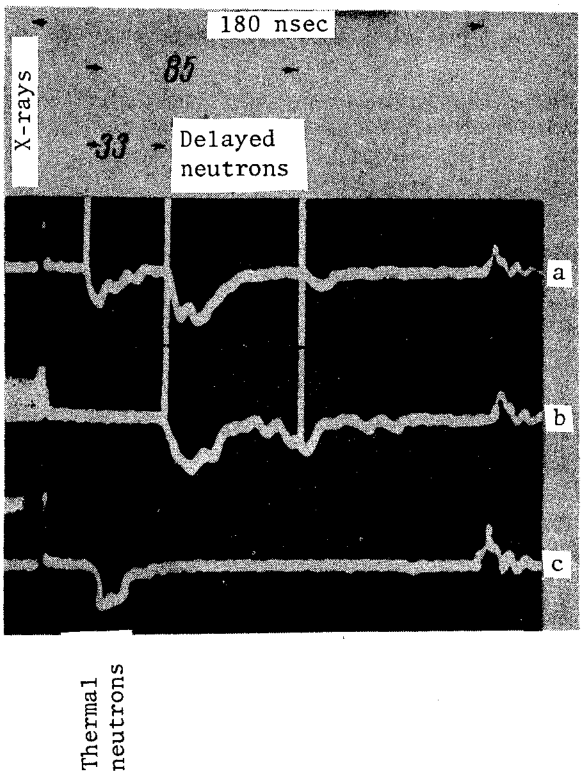

Fig. 1

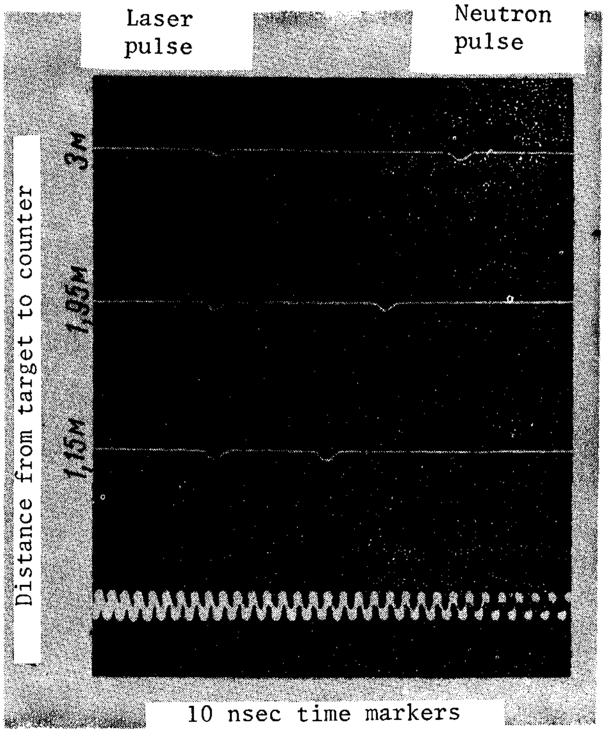

Fig. 2

We note also that neutrons produced directly in a laser plasma were registered in experiments with the simplest cumulation scheme, i.e., focusing of the radiation into a conical cavity in a massive target (Fig. 1c). No "delayed neutrons" were observed in this case. All these facts cast doubts on the conclusions of [3], where the appearance of fast ions is attributed to acceleration in the region of critical density $(\omega = \omega_{-})$.

The neutron-generation mechanisms described above operated, in all probability, also in other similar neutron experiments with sharp focusing [1 - 3, 7, 8], and particularly in [1], where the neutron yield was seen to depend on the gas pressure in the chamber, and in [2], where neutron generation was attributed to the appearance of fast deuterons (up to 20 keV) whose origin was ascribed by the authors to nonlinear heating mechanisms, but without doubting that the neutrons were produced directly in the plasma. It can also be assumed that the experimental conditions of [7], where the heating radiation was focused inside a solid deuterium target, are analogous to those with cumulation in a conical cavity.

3. Spherically symmetrical target irradiation. The laser power was 200 GW, the pulse duration 1.5 nsec, the target diameter 110 μ, and the neutron yeild 10^7 neutron/pulse. The neutron-pulse oscillograms obtained simultaneously by three scintillation detectors located at different distances from the target are shown in Fig. 2. The neutron energy, determined from the time of flight on the oscillograms, is ∿ 2.45 MeV, corresponding to the reaction $D(d, n)He^3$. The absence of "delayed neutrons" is apparently due to the high residual gas pressure (∿ 7 mm Hg).

The large neutron yield and the short lifetime of the dense plasma (∿ 1 nsec) made it possible to measure the width of the energy spectrum of the neutrons. This width is connected with the duration Δt of the neutron pulse, obtained from a detector located a distance L from the target by the relation $\Delta E_n = 2.74(E^{3/2}/L)\Delta t$ (MeV), where E is the neutron energy. The ion temperature of the plasma, assuming a Maxwellian distribution, is connected with the width of the neutron spectrum by the relation $\Delta E_n \simeq 82.5\sqrt{T_d}$(keV) [9]. Taking into account the temporal resolution of the apparatus (4.5 nsec), the plasma ion temperature does not exceed 5 keV, which points with a large probability to a thermal character of neutron generation in a spherically heated plasma. If this conclusion is accepted, then the relatively large neutron yield at a relatively low ion temperature and a small number of particles in the plasma can be attributed to the fact that the reaction proceeds mainly in a plasma shell with transcritical density.

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DOMAIN WALL CONFIGURATION IN CYLINDRICAL SILICON IRON CRYSTALS

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Information on the arrangement of the domain walls inside a ferromagnet is limited, since the picture of the interior is usually assessed from the emergence of the wall to the surface. Direct information on the internal domain structure is obtained with a neutron-optics method based on the study of neutron refraction by the domain walls under conditions of rather high angular resolution [1]. If the neutron beam is parallel to a certain wall system, there is no refraction by the system. This is manifest by a transmission maximum, so that the directions of the domain walls can be established thereby. Each pair of these directions defines one system of parallel walls. To find the indices $(hk\ell)$ of the plane to which they are parallel, it is necessary to solve a system of two equations of the type $hu + kv + \ell w = 0$, where u, v, and w are the indices of two directions corresponding to transmission maxima.

We investigated the domain-wall configuration in cylindrical (13 mm diam) Fe + 3.5% Si crystal of different height and different degree oq perfection. The neutron transmission measurements ($\lambda = 2.46$ Å) were made with a two-crystal spectrometer [1, 2]. The sample was placed between two germanium crystals in a parallel mount and rotated about the cylinder axis [001], which was perpendicular to the [100] axis, and also about the [110] axis. In all cases, the neutron beam was perpendicular to the rotation axis. A single-crystal quartz filter was used to suppress the neutrons of wavelength λ/n, which were present in the monochromatic beam.

The transmission curves (Figs. a and b) show distinct maxima corresponding to passage of neutrons along the domain-wall systems. The widths of the maxima are determined by the geometrical parameters of the wall systems, and the oscillations near them are due to the mutual influence of refraction by the neighboring parallel walls [1]. The smooth increase of the intensity with increasing distance from the maxima is connected with the weakening of the refraction effects with increasing an angle of incidence on the wall. The angular dependence of the transmission did not change qualitatively when the height of the sample was increased from 1.5 to 35 mm, or when the mosaic structure increased from the equivalent of several minutes to $\sim 1°$.

It was established from the indices of the directions corresponding to the maximum transmission (Figs. a and b) that the domain walls in the investigated crylindrical samples lie in four planes, (100), (010), (110), and $(1\bar{1}0)$, passing through the cylinder axis and in the plane