Thus, our data are in better agreement with the resonance interpretation of the near-threshold anomaly. The table presents, besides our data, also the results of measurements of the mass and the width of the observed effect in different experiments. As seen from the table, the obtained data do not suffice as yet for an unambiguous interpretation of the near-threshold anomaly in the spectrum of the $K_1^0 K_1^c$ system.

The second peak in the $K_1^0 K_1^0$ effective-mass spectrum at (1.28 ± 1.36) GeV/c^2 may be connected with the known decays of the f^0 and A_2^0 mesons via the $K_1^0 K_1^0$ channel. However, at the present statistics it is impossible to separate the contributions from these mesons.

In conclusion, the authors are deeply grateful to the laboratory group who took part in the reduction of the experimental data, to the various measurement groups, and also to the crew of the JINR proton synchrotron for irradiating the bubble chambers.

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EXPERIMENTAL OBSERVATION OF THE AMPLIFICATION OF LASER RADIATION IN THE INTERACTION OF COLLIDING LASER BEAMS IN A PLASMA

A.E. Kazakov, I.K. Krasyuk, P.P. Pashinin, and A.M. Prokhorov
P.N. Lebedev Physics Institute, USSR Academy of Sciences

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1. The present paper contains the results of an experimental investigation of the interaction of opposing laser pulses of picosecond duration in a plasma. The formation of a high-temperature dense plasma is connected with multiphoton ionization of the atoms of the gaseous argon in the field of the intense laser radiation [1]. In the case of unequal intensity of the pulses, an increase of the energy of the weaker pulse was observed, and also an appreciable modification of its spectrum.

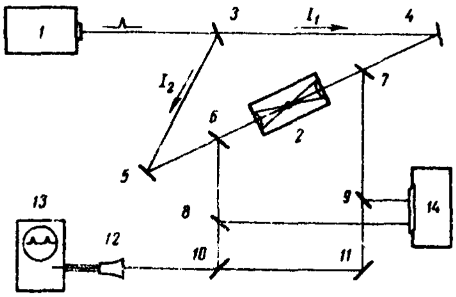

Fig.1

Fig.2

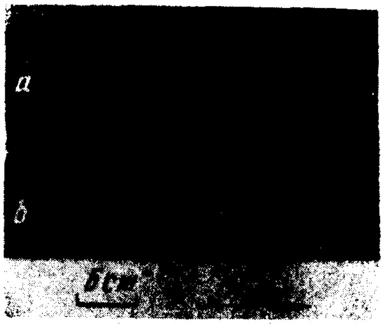

Fig. 1. Diagram of experimental setup: 1 - laser, 2 - chamber with two lenses, 3 - 11 - beam-splitting mirrors, 12 - coaxial photocell, 13 - oscilloscope, 14 - spectrograph.

Fig. 2. Spectrograms of laser radiation with intensity I_2 upon entering (a) and leaving (b) the plasma.

2. Figure 1 shows a diagram of the experimental setup. The laser system 1 generates a single optical radiation pulse of duration 20 - 100 psec and 6943 Å [2]. Mirror 3 splits the laser beam into two, which in turn are directed opposite to each other with the aid of mirrors 4 and 5. The optical paths were chosen such that both laser pulses pass simultaneously through the focal region of the confocal lenses of chamber 2. Both lenses have identical focal lengths, 2 cm. Mirrors 6, 10 and 7, 11 serve to measure the energy in beam 2 at the entrance and exit of the focusing region, respectively. The energy is measured with a calibrated system consisting of photocell 12 and high-speed oscilloscope 13. The time resolution of the entire system was 0.2 nsec and ensured sharp registration on the oscilloscope screen of both measured pulses, shifted by 10 nsec with the aid of an optical delay. The system consisting of mirrors 8 and 9 and of spectrograph 14 makes it possible to investigate the variation of the spectral composition of the laser pulse 2.

3. We obtained the following experimental results. At a laser pulse intensity $I_1 = 3 \times 10^{14}$ W/cm^2 and an opposing pulse intensity $I_2 = 0.2\ I_1$, amplification of beam 2 takes place by a factor 1.21 ± 0.02 after the beam passes through the focal region. The measurements were carried out at an argon pressure 0.4 atm in the chamber. The intensity of pulse 1 exceeds in this case by almost one order of magnitude the threshold breakdown value [1]. Since absorption connected with the inverse bremsstrahlung effect also takes place in the plasma, the true amplification k_0 is larger than the measured value k. The experimental measurements of the attenuation due to the bremsstrahlung absorption in the plasma gave a value 0.94 ± 0.02, which agrees with the theoretical estimate for the proposed plasma parameters: $T_e = 100$ eV, $n_e = 1.2 \times 10^{19}$ cm^{-3}. Taking into account the correction for the attenuation, the true amplification of the beam I_2 turns out to be $k = 1.32 \pm 0.03$.

With increasing beam intensity I_2 at a constant intensity I_1, the amplification coefficient of the second beam decreases appreciably. At an intensity $I_2 = 0.7\ I_1$, the measured amplification coefficient k amounts to 1.05 ± 0.02.

Control measurements have shown that the energy reflected by the plasma from the laser beam 1 into the direction of beam 2 is lower than the sensitivity threshold of the recording apparatus, and consequently does not influence the measured amplification of pulse 2.

Figure 2 shows spectrograms of the laser radiation before (a) and after (b) passing through the plasma. The broadening occurs in both directions of the initial laser line and amounts in this case to 4.3 cm^{-1} at an initial spectrum width 0.7 cm^{-1}.

4. One of the possible mechanisms of the observed phenomenon may be stimulated Compton scattering [3 - 6]. Let us estimate its effectiveness under our conditions. The equations describing the change of the intensities I_1 and I_2 of the beams propagating opposite to each other in the plasma have the following form:

$$dI_1/dz = dI_2/dz = BI_1(z)I_2(z) \qquad (1)$$

where

$$B = \frac{c^2 r_0^2}{\pi \nu^3} \frac{v_0}{kT} n_e \left(\frac{m}{2\pi kT}\right)^{1/2} \exp\left(-\frac{mv_0^2}{2kT}\right),$$

ν is the carrier frequency of the spectrum, and r_0 and n_e are respectively the classical radius of the electron and the number of electrons per unit volume. Equations (1) were obtained from the kinetic equation for the photon distribution function [7] with allowance for the drift velocity of the electrons v_0 opposite to the laser beam [8]. The spectra of both radiations were assumed to be rectangular and identical; it was also assumed that $\bar{v}/c \gg \Delta\nu/\nu$ ($\bar{v}$ - average thermal velocity of the electrons, $\Delta\nu$ - width of the emission spectrum). Since $I_2 \ll I_1$, we can easily obtain from (1) an expression for the amplification coefficient α of the wave I_1, assuming $I_1(z) = \text{const}$, namely $\alpha = BI_1$. For $v_0 = 10^8$ cm/sec, $kT = 100$ eV, $I_1 = 3 \times 10^{14}$ W/cm^2, $n_e = 1.2 \times 10^{19}$ cm^{-3}, we have $\alpha = 6.3$ cm^{-3}. At a laser-beam interaction-region length $L = 5 \times 10^{-2}$ cm, the amplification amounts to $k_0 = \exp \alpha L \simeq 1.36$, which agrees with the measured amplification.

The question of the change of the spectral composition of the laser radiation cannot be solved within the framework of the approximations made here, and will be investigated separately.

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