$\gamma = 3$ should be taken with caution because in these experiments it was not always possible to avoid an energy spread in the ion beam or other complicating circumstances.

The observed oscillation frequency is found to be approximately proportional to the ion velocity (cf. [6]). This is also in agreement with the solution ($w = kv/2$) of the appropriate dispersion equation if one assumes that K is determined by the transverse dimensions of the ion beam.

The experimental verification of the dependence of the threshold energy of the ion beam on electron temperature, predicted by theory, indicates the possibility of using the two-stream ion instabilitiy for thermalization of powerful ion beams in a plasma with high electron temperatures or for plasma diagnostic applications.

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Translated by H. Lashinsky
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A Q-SWITCHED OPTICAL MASER

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Submitted to JETP editor July 10, 1964

J. Exptl. Theoret. Phys. (U.S.S.R.) **47**, 1595-1597 (October, 1964)

THE instantaneous output power of an optical maser can be increased by using the well known method of Q-switching [1]. We have used an electro-optic shutter for controlling the Q. The laser is shown schematically in Fig. 1. The numbers in the figure have the following meaning: 1- a 90° oriented ruby crystal, 12 cm long, 0.9 cm in diameter, with a chromium ion concentration of 0.06%; 2- mirrors, the left hand one is a plane parallel glass plate without any coatings, the right hand one has a 98% reflectivity; 3- the laser crystal; 4- the Kerr cell; 5- a specially constructed polarizing prism. The ruby, the Kerr cell and the prism are oriented so that, in the absence of voltage on the Kerr cell, laser action in the ordinary ray is impossible (laser action was not observed in our experiments in the extraordinary ray).

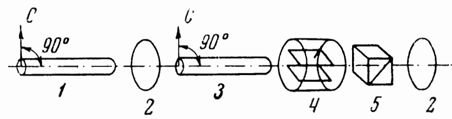

FIG. 1

The Kerr cell was operated by a voltage pulse which produced a phase difference of $\lambda/2$. The pulse duration was 0.5 μsec and its rise time was 5 nanoseconds. A delay line generator was used to produce the pulse [2].

The crystal was pumped with a helical flash lamp through which a 300 μf condenser bank at up to 8kV was discharged. Under these conditions the flash lamp took about 700 microseconds to rise to the 0.3 intensity level. At this excitation the crystal lased due to the Fresnel reflection from the uncoated ends of the ruby, provided the side wall of the crystal was rough ground. The occurrence of laser oscillation indicates that the negative absorption coefficient was not less than 0.22 cm^{-1}. It should be noted that, in the same crystal with a polished side wall, the coefficient of negative absorption could not be made greater than 0.16 cm^{-1}.

It is clear from Fig. 1 that when the shutter is closed the laser can oscillate using the reflections from the end wall of the laser crystal and the parallel plate which acts as a mirror. The plane parallel plate and the end face of the ruby opposite it form a compound interferometer with a maximum reflectivity of about 30%. During oscillation under these conditions the coefficient of negative absorption attains a value of 0.16 cm^{-1}. In order to attain maximum inversion the end faces of the crystal and the Kerr cell were anti-reflection coated to 1% at each surface. The polarizing prism was not coated and therefore its surfaces were canted at a 0.5° angle to the plane of the mirrors.

The voltage pulse was applied to the Kerr cell 550 μsec after the firing of the flash lamp. At this

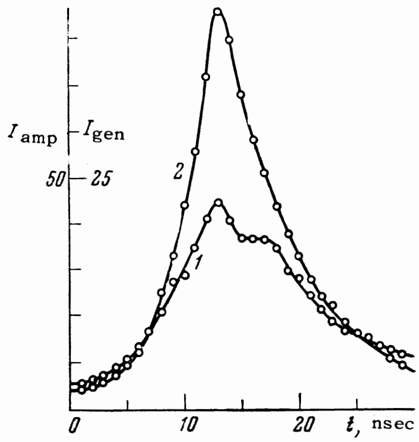

FIG. 2

time the maximum inversion in the crystal occurred.

The laser emits a single pulse having an energy of up to 1.8 joules. The energy was measured with a calorimeter [3]. The pulse shape in a case where the total energy was one joule is shown in Fig. 2, curve 1. The abscissa is marked in nanoseconds and the ordinate in arbitrary power units.

The pulse was detected with a fast photodetector having a time resolution of 1.5 nanoseconds.

The laser pulse was amplified in a laser amplifier. (The amplifier consisted of a crystal with coated end faces and a similar pump source.) At the amplifier output a single pulse was observed having an energy up to 8 joules. The pulse shape for a case in which the total energy was 3.3 joules is is also shown in Fig. 2, curve 2. The pulse shortening and the steepening of the front edge are clearly visible (the position of curves 1 and 2 with respect to each other is arbitrary).

The authors are grateful to V. P. Vinogradov, V. L. Lazarenko, T. I. Filippova and N. V. Filippov for help with this work.

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Translated by J. A. Armstrong
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TURBULENT HEATING OF A PLASMA IN A LINEAR DISCHARGE

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Submitted to JETP editor July 22, 1964

J. Exptl. Theoret. Phys. (U.S.S.R.) 47, 1597-1600 (October, 1964)

IN the course of experiments concerned with the anomalous interaction between plasmoids produced in a system designed for turbulent heating [1] we have observed intense heating of electrons as evidenced by intense x-ray radiation of great hardness emanating from the plasma volume. This effect cannot be attributed to turbulent heating by a magnetohydrodynamic wave since it is observed relatively rarely and has also been observed in control experiments in which the shock-excited circuit that produces the wave was not operated. It has been determined that the intense heating is observed in those cases in which an appreciable part of the energy of one of the injectors is discharged through the plasma along the magnetic field to the other injector. A linear experiment has been set up in which the discharge occurs between the end electrodes of the injectors and the effect is observed to be completely reproducible.

In Fig. 1 we show oscillograms of the longitudinal current obtained with a resistance of 0.1 Ω connected between the injectors. The current first grows aperiodically and then becomes characteristic of a periodic discharge. Intense heating of the plasma electrons is observed in this case. It should be noted that the experimental conditions

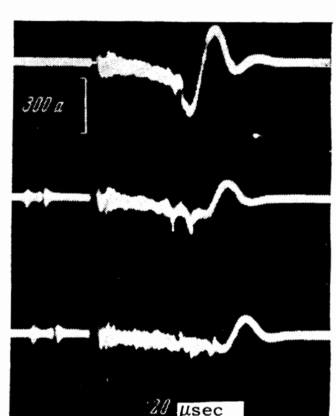

FIG. 1. Oscillograms of the longitudinal current. It is evident from the oscillograms that the heating due to the instability lasts from 14–20 μsec.