strong character of this decrease, we can expect the considered nonlinearity mechanism to turn out to be significant if not dominant at a large sound strength.

Obviously, the effect should be particularly noticeable at low temperatures. We note in this connection that motion of acousto-electric domains in CdS at T ≳ 60°K was observed in [10], but no domains were produced at T ≲ 40°K. It is necessary, however, to have additional data on the experimental conditions of [10] (in particular, concerning the strength of the sound) to be able to judge the possible role of the effect considered above.

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CONCERNING ONE POSSIBLE USE OF THE IR LASERS FOR HIGH-TEMPERATURE HEATING OF A SUPERDENSE PLASMA

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1. The main advantage of the laser method of high-temperature plasma heating, as is well known, is the possibility of attaining exceedingly high values of the specific energy input into the substance at low irradiation durations. In this method, the problem of confining the high-temperature plasma is eliminated in principle, since inertial confinement (IC) can be used because of the very short duration of energy supply. At the same time, the use of IC, with simultaneous requirement that the plasma be heated until the nuclear fusion energy exceeds the laser-pulse energy E consumed in heating, calls for a minimum required energy $E_{min} \sim 1/N_i^2$.[1] Such a dependence of E_{min} on N_i indicates

[1] Actually, from the condition of three-dimensional IC it follows that the volume V of the heated substance should satisfy the relation $\gamma V^{1/3} \simeq v_i(T)t$, where $v_i(T)$ is the average thermal velocity of the ions, t is the IC time, and the coefficient $\gamma < 1$ characterizes the degree of IC of the plasma. The minimal energy is

$$E_{min} \simeq 3kTN_i V = 3kT(v_i/\gamma)^3 N_i t^3.$$

The condition that the nuclear-fusion energy yield exceed the energy $3kTN_iV$ after a time t takes the form $N_i t > A(T)$ ($A \simeq 0.6 \times 10^{14}$ cm^{-3}sec for a 50% mixture of deuterium and tritium at $T = 10^8$°K). We then obtain

$$E_{min} > 3kT(Av_i/\gamma)^3 N_i^{-2}. \quad (1)$$

that the solid (or liquid) targets proposed in [1] are preferable. At a maximum ("solid-state") density $N_i \approx 5 \times 10^{22}$ cm^{-3} and $\gamma \approx 0.5$, according to [1], the minimum pulse energy is $E_{min} \gtrsim 10^6$ J at a pulse duration $\tau \lesssim \tau_{ei} \approx 10^{-9}$ sec. We note that at present this is the most optimistic estimate of the required laser energy, corresponding to the condition of three-dimensional IC of the heated plasma. However, the realization of such a laser method of heating remains problematic, since difficulties arise in connection with feeding the radiation energy into a superdense plasma, i.e., a plasma for which $\omega_p \equiv (4\pi e^2 N_e/m)^{1/2} > \omega$ (ω is the cyclic frequency of the radiation).

2. In the present article we discuss one possibility of solving the problem of feeding the radiation energy into the superdense plasma produced in laser experiments.

It is known (see, e.g., [2]) that when a sufficiently strong constant magnetic field H_0 is applied to a plasma, propagation of a definite type of waves becomes possible in the plasma in a quasi-longitudinal direction even when $(\omega_p/\omega) > 1$. More accurately speaking, such a propagation is possible if

$$(\omega_H/\omega)\cos\phi > 1, \quad (2)$$

where $\omega_H = eH_0/mc$ is the gyromagnetic frequency of the electron, and ϕ is the angle between the wave propagation direction and the magnetic field H_0. For the case of a gas plasma, such a "penetration" effect was observed in experiments on sounding the earth's ionosphere (see [2]). This effect is particularly striking in certain experiments on the observation of microwave propagation in metals and semimetals (see the reviews [3, 4]), where $(\omega_p/\omega) \gg 1$.[2)]

As applied to laser heating of a superdense plasma, the condition (2) can be realistically satisfied at $\phi \ll 1$ for IR lasers, for example CO_2 lasers with $\lambda = 10.6\ \mu$ ($\omega = 1.78 \times 10^{14}$ sec^{-1}), where the corresponding critical magnetic field is $H_0 = 10^7$ G ($\omega \approx \omega_H$). Such a superstrong magnetic field is now already attainable at a duration $\sim 10^{-6}$ sec using modern magnetic cumulation techniques (see [6, 7]). It should be borne in mind, however, that condition (2) is only the condition for the existence in a superdense plasma of a normal type of wave possessing a real refractive index. The main question is the effectiveness with which such a wave can be excited in a superdense plasma by incident external laser radiation. It turns out that for converging circularly-polarized laser beams with sufficiently small angular aperture ϕ_0, the energy coefficient D for conversion into a wave propagating in the region $(\omega_p/\omega) > 1$ can be quite close to unity. Quantitatively this condition takes the form (see [2]):

Obviously, it is necessary that the time t satisfy simultaneously the conditions $t \gtrsim \tau$ and $t \gtrsim \tau_{ei}$, where τ is the duration of the laser pulse and τ_{ei} is the time of electron-ion thermalization. Satisfaction of the latter condition automatically leads to satisfaction of the inequality $N_i t > 0.6 \times 10^{14}$ cm^{-3}sec, since $\tau_{ei} \approx 0.7 \times 10^2 T_e^{3/2}/N_i$. The pulse duration must satisfy the condition $\tau \lesssim \tau_{ei}$).

[2)] In the case of a "solid-state" plasma, the effect becomes somewhat more complicated because of the possible presence of several types of free carriers. Accordingly, the so-called helical (helicon) and Alfven types of waves appear. We note that one of the first experiments on observation of electromagnetic wave propagation in bismuth was performed in our laboratory [5].

$$D \approx 1 - 1/\eta ,$$

$$\eta \equiv \frac{\lambda}{\pi^2} \frac{(1-\omega/\omega_H)^{3/2}}{\phi_0^2} \left(\frac{N_e'}{N_e}\right)_{\omega \approx \omega_p} >> 1 \tag{3}$$

(λ is the wavelength in free space, N_e' is the derivative of the electron density N_e with respect to the longitudinal coordinate). It is seen from (3) that for effective excitation of the wave in a superdense plasma it is necessary to have not only small angles ϕ_0 but also sufficiently large gradients of the electron concentration N_e at the point $\omega_p > \omega$. The latter is connected with the fact that the very possibility of exciting an electromagnetic wave in the region $\omega_p > \omega$ is due to violation of the conditions of geometrical optics at the point $\omega_p > \omega$ for both types of wave (ordinary and extraordinary), and consequently to the transformation of one type of wave into another (see [2], Sec. 28). At $(\omega_H/\omega) = 2$, the condition (3) is satisfied for CO_2 laser radiation if the width $\Delta Z = (N_e/N_e')_{\omega_p \approx \omega}$ satisfies the inequality

$$\Delta Z << 3 \cdot 10^{-5} \phi_0^{-2} \text{ (cm)}. \tag{4}$$

To feed effectively the entire-laser-pulse energy into the superdense plasma produced by this pulse, it is necessary that condition (4) be satisfied during the duration τ of the entire pulse, i.e., at $\Delta Z = \Delta Z_{max} \equiv \Delta Z(\tau)$. For a density $N_i = N_e \simeq 5 \times 10^{22}$ cm^{-3} and $T_e = 10^8$°K, the time of electron-ion thermalization $\tau_{ei} \simeq 10^{-9}$ sec. Therefore, at a pulse duration $\tau \simeq 10^{-9}$ sec we have $\Delta Z_{max} \simeq v_i(T)\tau \simeq 10^{-1}$ cm, and condition (4) leads to the requirement $\phi_0 < 2 \times 10^{-2}$ rad. In the region of the caustic of the focusing system, this condition on the angle ϕ_0 can apparently be experimentally satisfied. It is, however, greatly facilitated by changing over to much shorter pulse durations $\tau << \tau_{ei}$. Thus, at $\tau \simeq 10^{-10}$ sec the value of ΔZ_{max} is determined by the thickness of the "electron jacket" surrounding the cold ions, and at $T_e \simeq 10^8$°K it amounts to $\Delta Z_{max} \simeq (kT_e/e^2N_i)^{1/2} \simeq 10^{-6}$ cm. Condition (4) is then practically always satisfied.

3. Since the examined feasibility of feeding the radiation energy into a superdense plasma entails the use of a longitudinal magnetic field, it admits simultaneously of use of magnetic thermal insulation of the plasma and of the cylindrical "heavy shell" proposed in [8].

It follows from [8] that in the presence of a magnetic field of intensity $H_0 \simeq 10^7$ G, the cross section area S of the target placed in the cylindrical "heavy shell" can be chosen to be $\sim 10^{-4}$ cm^2 (i.e., a diameter $d \simeq 10\lambda$ for CO_2 laser radiation). For the minimum laser energy E_{min}, estimated from the condition of one-dimensional IC and from the requirement $N_i t > A(T)$ (in analogy with (1)), we then obtain ($\gamma \simeq 0.5$)

$$E_{min} > 3kT v_i AS/\gamma \approx 3 \cdot 10^3 \text{ J}, \tag{5}$$

i.e., a quantity smaller by two-and-a-half orders of magnitude than the most optimistic estimate known at the present time. We note that in this case E_{min} does not depend on N_i and therefore the target density, and with it the pulse duration τ, can be varied within certain limits. In the case of the "solid-state" density $N_i = 5 \times 10^{22}$ cm^{-3}, the indicated CO_2-laser energy should be generated within a time $\tau \lesssim 10^{-9}$ sec. It is not advisable to go to much lower target densities (and consequently lower N_i) in this situation, since this increases the length of the target needed for the IC. We note that under the considered conditions, for a "solid-state" plasma density, the absorption of radiation even at the maximum temperature $T = 10^8$°K is always large, owing to the cyclotron resonance, and the condition $\alpha^{-1} < (v_i\tau_{ei}/\gamma)$ is certainly satisfied (α is the absorption coefficient of the magnetoactive plasma for a wave of the corresponding type with account taken of the thermal motion of the electrons, see [2]).

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REGGE BRANCH CUTS AND DISTRIBUTION OF HADRON MULTIPLICITY AT HIGH ENERGY

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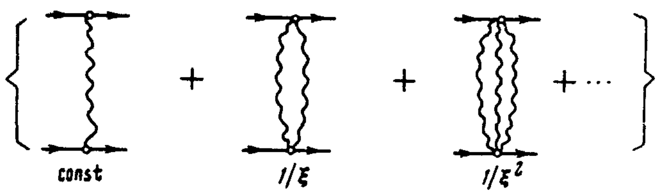
We consider here the influence of multi-pomeron exchange on the structure of the particle-number distribution function at high energies. It is usually assumed that the quantities $w_n = \sigma_n/\sigma_{tot}$ have a Poisson distribution or close to it. Such a result is obtained in multiperipheral models [1] and is connected with the finite radius of the longitudinal correlation in momentum space [2]. Multi-pomeron branch cuts lead, first, to another particle production mechanism (roughly speaking: exchange of ν pomerons (P) denotes that ν times more particles were produced in the s-channel), and second, lengthen considerably the correlation radius (owing to the enhanced diagrams [3]). All this can change the structure of the distribution of w_n, and we consider below the form of w_n taking only P exchanges into account, and assuming that $\xi = \ln s$ is not small.

We disregard the enhanced branch cuts at first. Then the total cross section is given by the sum of diagrams

$$\sigma_{tot}(\xi) = s^{-1}\,\mathrm{Im}\,A(s,0) =$$

$$= s^{-1}\frac{(\mathrm{disc})_s}{2i}\left\{ \quad + \quad + \quad + \cdots \right\} \qquad (1)$$



where we have shown the contributions of the pole P, of the branch cuts (PP),