whence

$$S(E) = \int \frac{\rho^2}{2} \, d\phi = \frac{g^2(k_z)}{2E^2} \int_0^\pi \cos^2\phi \cdot d\phi = \frac{\pi g^2(k_z)}{4E^2} \quad ,$$

where the integrals are taken over the region where $\cos\phi > 0$.

We thus get for the spectral density $\nu(E)$

$$\nu(E) \approx dN/dE = A(k_z)/E^2 \quad \text{where } A(k_z) = \pi^2 m^* g^2(k_z)/\hbar^2$$

and

$$N(E) = - A(k_z)/E \quad .$$

Consequently, the discrete levels form a sequence that decreases like

$$E_N = - \frac{A(k_z)}{N} + O\left(\frac{1}{N^2}\right) \quad . \tag{2}$$

Concerning the occurrence of localized states near the dislocation itself, we can state the following: if the perturbation produced by the nucleus of the dislocation is sufficiently large, then the levels due to the perturbation are "deep" and lie lower than the first level determined by (2). Near the boundary of the spectrum of an ideal crystal, the local level is produced with energy

$$E_o = - \frac{\hbar^2 \kappa_o^2}{2m^*} \exp\left(- \frac{2\pi\hbar^2}{m^* g_o(k_z)}\right)$$

(κ_0 is a constant on the order of the limiting wave vector of the quasiparticle). Since the width of the band of an ideal crystal is

$$\Delta E_{id} = \frac{\pi^2\hbar^2}{2|m^*|} \quad ,$$

it follows that separation of the "deep" level E_0 from the levels (2) occurs under the condition

$$2\left(\frac{\kappa_o}{\pi^3}\right)^2 \left(\frac{\Delta E_{id}}{g(k_z)}\right)^2 << \exp\left(- \frac{4}{\pi} \frac{\Delta E_{id}}{g_o(k_z)}\right).$$

[1] I.M. Lifshitz and A.M. Kosevich, Dynamics of a Crystal Lattice with Defects, Preprint, Physico-tech. Inst. Ukr. Acad. Sci., Khar'kov, 1965.

TIME OF START OF SCREENING OF A SURFACE EVAPORATING UNDER THE INFLUENCE OF LASER RADIATION

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The breakdown of a cold gas under the influence of a laser beam is a well-known phenomenon, for which a theory has already been developed (for a description of the phenomenon and for a review of the initial investigations, see [1]). It is of interest to investigate the analogous phenomenon, the heating of the vapor produced under the influence of a laser beam, together with the

occurrence of strong ionization, absorption of optical radiation, and screening of the evaporating surface. The heating of such a vapor should differ significantly from cascade ionization, for the following reasons: The vapor is noticeably ionized from the very instant of its formation (at the phase transition temperatures, and at pressures on the order of $10^2 - 10^3$ bar, a typical value of the degree of ionization α_e is of the order of 10^{-4}. of the total number of particles). Therefore, the number of electron-electron, ion-ion (or atom-atom) collisions is such that one can speak of electron and ion temperatures (T_e and T_i; the latter is equal to the atomic temperature). The time of equalization of these temperatures is of the same order of magnitude as the characteristic time of the action, or is even shorter. One of us developed in [2, 3] a theory of a full-equilibrium "flash" (as distinguished from a breakdown), when T_e and T_i coincide, and the degree of ionization α_e "follows" the equilibrium temperature of the substance in accordance with the Saha equation. Account was taken there also of the cooling of the vapor, an important factor when the vapor expands in vacuum or in a low-density medium.

It should be noted that such a "flash" occurs in the case of practically transparent vapor (for example, for aluminum at an optical thickness 0.01). The calculated values of the flux density q_* at which the "flash" is produced in hot vapor is much lower than the corresponding values needed for breakdown in cold gases, at the same values of the time. However, as shown by a comparison of the results of experiments by A.I. Petrukhin et al. [4] and calculations by V.I. Bergel'son based on the theory of [2, 3], for the actual pulse shape used in [4] the screening sets in at even lower values of q than expected from the indicated calculations. It was therefore necessary to analyze anew the initial premises of [2, 3], and above all the assumed proximity to the ionization equilibrium.

Estimates [5] indicate that at the flux-densities prevailing in [4], $q \leq 10^3$ mW/cm^2, we have $(T_e - T_i) \ll T_e \simeq T$. Actually, however, the criterion for a weak influence of the difference between the electron and atom temperatures, by virtue of the strong exponential $\alpha_e(T)$ dependence, should be not the foregoing inequality, but the stronger one $(T_e - T_i)(I/T_e) \ll T_e$ (we note that at temperatures close to the phase-transition temperatures I/T is of the order of 10 - 20). Moreover, an increase of T_e and α_e, and accordingly of the absorption coefficient, in free-free transitions of the electrons in the field of ions and neutral atoms, leads to a still larger increase of $T_e - T_i$ and to bound-free transitions from their highly excited states.

We note that an effect of this type was already noted in [6] in estimates of the start of screening of radiation of a strong shock wave by the gas ahead of its front; this radiation, as follows from the corresponding e periments, also occurs earlier than called for by the pure equilibrium theory.

We have therefore made estimates similar to those of [2, 3], but with account taken of the difference between T_e and T_i, and of the finite ionization rate. The resultant system of equations is quite obvious and is omitted to save space (a detailed description of the assumptions made and of the calculation procedure will be published soon). The results of the calculations (for a flux constant in time) are shown in the figure in the form of the dependence of the time t (in microseconds) of the "flash" development (after the start of the evaporation, the boundary of the "flash" is arbitrarily assumed to be $\alpha_e = 0.4$) on the radiation flux density q (in mW/cm^2) at a quantum energy $\varepsilon = 1.78$ eV (ruby laser), for several substances, assuming full equilibrium (dashed curve)

and with allowance for the difference between T_e and T_i (solid curve). It is easy to see that allowance for this difference greatly lowers the "critical" density q_* corresponding to the start of screening at a specified time t, or the time t_* of its development if q is given. At $t_* = 0.06$ μsec we get $q_* = 40$ mW/cm² for Pb and 140 mW/cm² for Al.
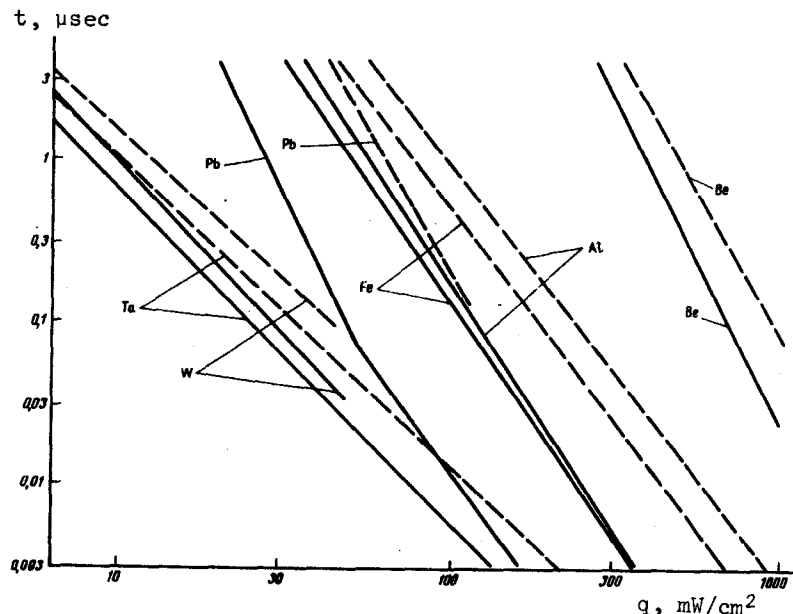
For $\varepsilon = 1.16$ eV (neodymium laser), the difference between the electron and ion temperature produces a stronger effect (the time is decreased by an approximate factor 1.5).

It follows from the plots shown in the figure that in the case of the times typical of the laser giant-pulse regime the critical value of q_* is much lower (by more than one order of magnitude) than the value obtained in [7] for q at the maximum of the ratio of the pulse to the supplied energy. It follows therefore that under the conditions of the experiments [7, 4] the screening sets in already in the stage when the heat conduction exerts a noticeable influence, and leads in this case to a certain increase of the pulse at the beginning.

The results of our calculations agree better than the results of [2, 3] with experiment [4], but the screening sets in, as before, at somewhat lower fluxes than called for by these calculations.

The parameters of the vapors under the influence of a free-running laser were investigated experimentally in [8] under conditions of "weak" focusing, in the flux density range 2 - 20 mW/cm² (average for a spike of approximate duration 1 μsec, at a characteristic dimension of about 3 mm). As follows from the figure, screening should be observed in this range (or at any rate near its upper limit), at least for certain substances (for example, for W and Ta, which were not investigated in [8]). It is of interest to verify whether screening actually occurs in the indicated ranges of q and t. This would make it possible to ascertain whether the $q(t)$ dependence obtained by us agrees with experiment. The very occurrence of such a screening would uncover the possibility of obtaining a plasma with the aid of a laser at very low flux densities (much lower than in [4] or [7]), and consequently at sufficiently large dimensions of the exposed "spot" and plasma could, and at much longer times of its existence.

We note that additional lowering of q and t can occur as a result of the nonuniformity of the illumination of the spot, temporal pulsations of the flux, and many other factors (for example, as already indicated in [3], the air resistance, whichleessens the role of adiabatic cooling of the expanding vapor, shortens the "flash" time).

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E R R A T A

In the article by Gnoevoi et al., Vol. 11, No. 9, page 297, the correct initials of the first author (Gnoevoi) are Ya.T. and not Ya.N.

In the article by I.V. Menchinov and S.P. Popov, Vol. 11, No. 9, page 315, in the references, read [4] "Ya.T. Gnoevoi" instead of [4] Ya.N. Gnoevoi,"