as a result, a definite contribution to the dimension of the focal spot may be made by effects of thermal conductivity (this was indicated in [7]).

5. Nonstationary thermal self-focusing was cited by a number of writers [8] as an explanation for the damage to crystals and glasses in the field of laser pulses of duration from 10^{-4} to 10^{-8} sec. However, the authors of these papers used the formulas of the stationary theory.

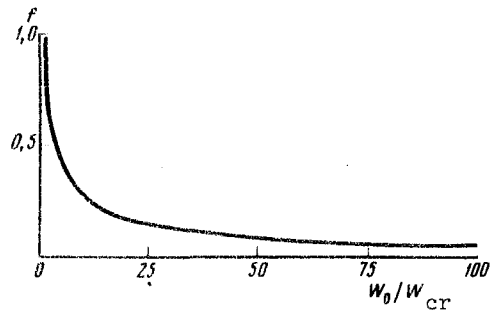

Fig. 3. Dependence of the dimensionless width of a Gaussian beam at the focus on the ratio of the beam energy to the critical energy. We see that the inertia of the nonlinearity leads to a limitation of the field at the focus ($f_{min} \neq 0$) even for $(W_0/W_{cr}) \geq 10^2$.

The foregoing results enable us to determine quantitatively the dimensions and the positions of the regions of the strong field and to determine distinctly the contribution of the thermal self-focusing to damage to dielectrics.

6. Self-defocusing in a medium with inertial nonlinearity. The foregoing procedure is fully applicable to an analysis of nonstationary self-defocusing. The corresponding solution of the equation for the defocusing medium is shown in Fig. 1, curve 2. The dynamics of the nonstationary defocusing is shown in Figs. 2d, 2e, and 2f. The region of maximal expansion moves with a velocity $u_p = (2/3)u$. The divergence of the radiation is different for different sections of the pulse; the latter leads to strong distortions of the shape of the light pulse on the axis $P_0(\eta)/f^2$.

It should be emphasized that the foregoing approach makes it possible to calculate the internal self-defocusing which takes place for the case when the beam of a powerful laser diverges strongly in the nonlinear medium itself.

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LUMINESCENCE OF THE LOCAL CENTER OF A CRYSTAL IN THE PRESENCE OF UNIAXIAL DEFORMATION

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The Jahn-Teller instability, which is produced in an excited F-term of an octahedral local center because of the interaction with tetragonal (E)

vibrations, leads to the appearance of three equivalent minima of the adiabatic potential in the two-dimensional space of the E coordinates[1]. We shall show that from measurements of the temperature dependence of the linear dichroism of the luminescence, due to a uniaxial elastic deformation of the crystal, it is possible to extract directly an important characteristic of the electron-vibrational interaction, namely the square of the overlap integral $e^{-\sigma}$ of the wave functions of the fundamental vibrational states pertaining to different minima of the adiabatic potential (see (9) and (11)).

Let us consider an optical transition of the F → A type. In the case of a deformation along <110>, the Hamiltonian can be written in the form

$$H = H_0 + V + W, \tag{1}$$

$$H_0 = \sum_{i=2,6} \left(\frac{P_i^2}{2M_i} + \frac{1}{2} \kappa_i Q_i^2 \right) + \beta t_2 Q_2 , \tag{2}$$

$$V = \gamma t_6 Q_6, \quad W = -FQ_6 \tag{3}$$

(the terms that depend on Q_3, Q_4 and Q_5 make no contributions to the dichroism). Here Q_i are the normal coordinates of the octahedral complex after Van Vleck [1], β and γ are the constants for the coupling with the E and T vibrations, respectively, F is proportional to the deformation, and t_i are the electronic operators on the wave functions of the excited state:

$$t_2 = \begin{bmatrix} 1 & & \\ & -1 & \\ & & 0 \end{bmatrix}, \quad t_6 = \begin{bmatrix} 1 & & \\ & 1 & \\ & & \end{bmatrix}. \tag{4}$$

The intensity of the luminescence with polarization η is given by

$$I_\eta = Z^{-1} \mathrm{Sp}\, \rho\left(\frac{1}{kT}\right) P_\eta^+ P_\eta , \qquad Z = \mathrm{Sp}\, \rho\left(\frac{1}{kT}\right), \tag{5}$$

where P_η is the dipole-moment operator. Regarding V + W as a perturbation, we expand the density matrix $\rho(\lambda)$ in a series up to terms of second order inclusive, and use the coordinate representation for $\rho_0(\lambda) = \exp(-\lambda H_0)$ [2]. We then obtain for the ratio of the intensities of the parallel and perpendicular components of the luminescence

$$r = \frac{I_{\parallel}}{I_{\perp}} = 1 - 2F\gamma\Delta, \tag{6}$$

$$\Delta = \frac{1}{\kappa_T kT} \int_0^1 \exp\left[- \frac{2\sigma \operatorname{sh} \xi (1-x) \operatorname{sh} \xi x}{\operatorname{sh} \xi} \right] dx, \tag{7}$$

[1] The interaction with the trigonal (T) vibrations is relatively small. The reason is that the electron wave functions of the F term are "oriented" along a fourfold axis, and therefore the radial (type E) displacements of the nuclei lead to a larger change of the energy than the tangential (type T; for details see the review [1]).

$$\xi = \frac{\hbar\omega_E}{2kT}, \qquad \sigma = \frac{2\beta^2}{\hbar\omega_E \kappa_E} \equiv \frac{3\mathcal{E}}{\hbar\omega_E}, \tag{8}$$

where $\mathcal{E}$ is the Jahn-Teller energy of the E oscillations. The temperature dependence of Δ, described by formula (7), has the following form:

$$\Delta = \frac{e^{-\sigma}}{\kappa_T kT} \qquad (T \ll T_1), \tag{9}$$

$$\Delta = \frac{\kappa_E}{\beta^2 \kappa_T} \qquad (T_1 \ll T \ll T_2), \tag{10}$$

$$\Delta = \frac{1}{\kappa_T kT} \qquad (T \gg T_2), \tag{11}$$

$$kT_1 = \frac{1}{2}\hbar\omega_E \sigma e^{-\sigma}, \qquad kT_2 = \frac{1}{2}\hbar\omega_E \sigma. \tag{12}$$

Formula (10) (without limits of applicability) was obtained by Shimada and Ishiguro [3], who took into account only the static effect of rotation of the dipole moments of the transition, neglecting the distortion of the nuclei completely. At high and at low temperatures, the main contribution is made by the splitting of the electron level, and formula (6) can be represented in the form $r = 1 - (\delta E/kT)$. The splitting $\delta E = (2E_\gamma/\kappa_T)S$, where S is the square of the overlap integral of the vibrational functions. When $T \gg T_2$, the principal role is assumed by the highly-excited vibrational states, for which $S = 1$ and we arrive at formula (11). When $T \ll T_1$, only the ground vibrational level is populated, and for this level $S = e^{-\sigma}$, which leads to formula (9). There occurs, as it were, a decrease of the perturbation (meaning of the splitting δE) due to the presence of the Jahn-Teller interaction [4]. Thus, the most essential deviations from formula (10), which are connected with allowance for the kinetic energy in the Hamiltonian (2), occur at high and at low temperatures.

We performed numerical calculations for KI:Tl^+, using the following data [3]: $|\beta| = 0.28$ eV/Å, $\kappa_E = 2.7\nu$ eV/Å^2, and $\kappa_T = 1.3\nu$ eV/Å^2, where ν is a number on the order of unity. If we put $\nu = 1$ and $M_E = M_i = 2.1 \times 10^{-22}$ g, then $\hbar\omega_E/k = 110$°K and $\sigma = 6$. We then get $T_1 = 0.8$°K and $T_2 = 330$°K. Under the experimental conditions of [3], $2°K \leq T \leq 70°K$, and consequently the static approximation (10) is valid. Observation of the temperature dependence of Δ, due to the dynamic effects, is much easier for centers with a weaker coupling $|\beta|$ and with larger frequency ω_E. Thus, for example, for $|\beta| = 0.20$ eV/Å and with the other parameters fixed, we have $\sigma = 3$, $T_1 = 8.2$°K, and $T_2 = 165$°K.

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