mm/sec and H = 389 kG, obtained from the spectrum d_1, for which $\theta = 0°$ and, as follows from (3), expression (1) is valid. By solving Eq. (4) we obtained the following values of ε_n: $\varepsilon_1 = 4.382$ mm/sec, $\varepsilon_2 = 1.154$ mm/sec, $\varepsilon_3 = -1.648$ mm/sec, and $\varepsilon_4 = -3.888$ mm/sec. From this we readily find that $|E_1(Q)| = |E_3(Q)|$ and $|E_2(Q)| = |E_4(Q)|$, and, as seen from the table, all the calculated values of $E_n(Q)$ agree fully with experiment.

Thus, starting with the Hamiltonian (2) chosen by us, we calculated the levels of the hyperfine structure of the Fe^{57} nuclei in the d-sublattice of the garnet, and the agreement between the calculations and the experiment confirms the validity of our model, in which the energies of the quadrupole interaction are different for all the hfs levels. We have shown by the same token that to calculate the internal magnetic fields H when $E_n(Q) \neq 0$ it is necessary to use only the positions 2 and 4 or 3 and 5 of the spectral lines.

We have measured accurately, for the first time, the parameters of the quadrupole interaction in the d-sublattice at room temperature, something usually impossible to do because $\theta = \cos^{-1}(1/\sqrt{3})$ for these positions in the absence of an external field. The gradient of the electric field intensity in the d-sublattice at room temperature is $q = -2.1 \times 10^{24}$ cm^{-3}, for $Q = +0.33$ barn [3].

A determination of the degree of level "mixing" yielded a value on the order of several per cent, and therefore no additional lines were observed in the spectrum.

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THERMAL SELF-FOCUSING OF LASER RADIATION IN MEDIA WITH NEGATIVE dn/dT

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Submitted 5 January 1970
ZhETF Pis. Red. 11, No. 3, 177 - 181 (5 February 1970)

The propagation of laser radiation in weakly-absorbing media causes the latter to be heated and to experience a change in the refractive index. In media in which n increases with the temperature T, i.e., where $dn/dT > 0$, self-focusing is possible [1], while in media with $dn/dT < 0$ the laser radiation can become defocused [2].

Thermal self-focusing of the radiation of a pulsed laser was observed experimentally in ruby and sapphire crystals [3] and in colored glasses [4]. Self-focusing of radiation of CW lasers was also observed in glasses and lithium niobate crystals [5, 6]. In all these materials, $dn/dT > 0$[1)].

In substances for which $dn/dT < 0$, the thermal self-focusing is possible in principle for laser pulses of duration $\tau < \tau_0$ ($\tau_0 = a/v$, where a is the radius of the light beam and v the speed of sound), when the density of the medium in the light channel cannot change during the time of the pulse. Such a possibility was discussed in [7]. We note also the special case of self-focusing in beams having an intensity that increases towards the periphery [8].

We have previously observed [9] filament-like damage due to thermal self-focusing of

[1)] We refer to the experimentally measured dn/dT at constant pressure.

the radiation from a free running laser ($\tau \sim 5 \times 10^{-4}$ sec) in KDP and ADP crystals ($dn/dT < 0$) for the extraordinary beam. The large duration of the laser pulse ($\tau \gg \tau_0 \sim 10^{-7}$ sec) and the Gaussian profile of the beam (single-mode regime) do not make it possible to attribute the thermal self-focusing to the effects considered in [7, 8].

The purpose of the present paper is to show that under definite conditions thermal self-focusing is possible in solids with $dn/dT < 0$ for pulses of arbitrary duration.

When an isotropic medium is heated, the change of its refractive index is due to the change of density and temperature:

$$dn = \left(\frac{\partial n}{\partial \rho}\right)_T d\rho + \left(\frac{\partial n}{\partial T}\right)_\rho dT. \tag{1}$$

Under equilibrium conditions (homogeneous heating and free boundaries of the medium) we have $d\rho = -\alpha\rho dT$, where α is the coefficient of thermal expansion and

$$\left(\frac{dn}{dT}\right)_0 = -\alpha\left(\rho\frac{\partial n}{\partial \rho}\right)_T + \left(\frac{\partial n}{\partial T}\right)_\rho. \tag{2}$$

For many substances, the first term in the right-hand side is larger than the second, and the equilibrium values of $(dn/dT)_0$ are negative. The quantity measured in ordinary experiments is precisely $(dn/dT)_0$.

When a medium is heated by a laser and the diameter of the light beam is much smaller than the transverse dimension of the substance, a temperature gradient perpendicular to the beam axis is produced in the medium, with the ensuing thermoelastic stresses. Under these conditions, the density of the medium in the light channel exceeds its equilibrium value $\rho_0(1 - \alpha dT)$.

For a cylindrical sample of radius R and temperature profile T(r) [10] we have

$$\frac{\delta\rho(r)}{\rho} = -\frac{\alpha}{3}\frac{(1+\nu)}{1-\nu}\left[\delta T(r) + \frac{4(1-2\nu)}{(1+\nu)R^2}\int_0^R \delta T(r) r\,dr\right], \tag{3}$$

where ν is the Poisson coefficient. In the interval of r of interest to us ($r \ll R$) we have

$$\frac{\delta\rho}{\alpha} \approx -\frac{\alpha}{3}\frac{1+\nu}{1-\nu}\delta T(r), \tag{4}$$

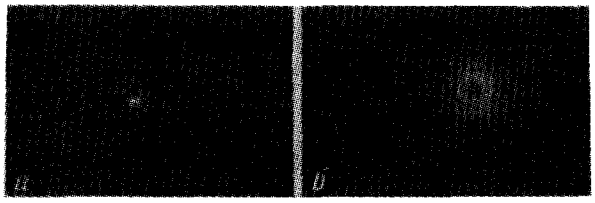
and

$$\frac{dn}{dT} = \left(\frac{dn}{dT}\right)_0 + \Delta, \tag{5}$$

$$\Delta = \frac{2}{3}\alpha\frac{1-2\nu}{1-\nu}\left(\rho\frac{\partial n}{\partial \rho}\right)_T. \tag{6}$$

Thus, self-focusing is possible if

$$\frac{dn}{dT} = \left(\frac{dn}{dT}\right)_0 + \Delta > 0. \tag{7}$$



a) Compression of light beam in "e" polarization; b) expansion of light beam in "o" polarization.

For short pulses ($\tau \ll \tau_0$)

$$\frac{dn}{dT} = \left(\frac{dn}{dT}\right)_0 + a\left(\rho\frac{\partial n}{\partial T}\right)_T. \tag{8}$$

We note that condition (7) is valid for all laser-pulse durations. For solid dielectrics, Δ is positive and its estimated value is $(1 - 5) \times 10^{-5}$ deg^{-1}. This is commensurate with the negative value of $(dn/dT)_0$ for most materials.

The correctness of the arguments presented here was verified experimentally in the following manner: we observed the change of the refractive index of KDP and ADP samples heated (without damage) by radiation from a one-mode neodymium-glass laser ($\tau_{pulse} \sim 250$ μsec, output energy up to 0.1 J). The laser beam, of 1.5 mm diameter, was focused with a lens having f = 10 cm. The samples, measuring 20 x 20 x 20 mm, were placed 0.5 cm behind the focus; the beam diameter in the sample was 10^{-2} cm. The change of the refractive index as a result of heating was monitored with the aid of a probing one-mode neon-helium laser, whose beam passed through the sample along the same optical path. For "e" polarization of the sounding beam, contraction of the light beam was observed on a screen located 1 m away from the sample, accompanied by a bright spot in the center (Fig. a), for both the KDP and ADP. In the case of "o" polarization of the sounding beam, the light beam broadened and a dark region surrounded by rings appeared in the center (Fig. b). A change of the polarization of the heating neodymium-laser beam did not change this picture. The lifetime of the positive increment Δn of the refractive index for the "e" beam and of the negative Δn for the "o" beam was estimated by observing the signal of the sounding beam with a photomultiplier and diaphragm, located in place of the screen. The duration amounts to ~ 3 msec, and coincides with the time of thermal relaxation from the channel heated by the laser beam.

The observed phenomena show that for KDP and ADP the condition (7) is satisfied only for "e" polarization. Indeed, according to the estimate, the value $\Delta \sim 3 \times 10^{-5}$ deg^{-1} cancels the values $(dn^e/dT)_0 = -2.4 \times 10^{-5}$ deg^{-1} and 0.1×10^{-5} deg^{-1} for KDP and ADP respectively, but is insufficient to cancel $(dn^o/dT)_0 = -5 \times 10^{-5}$ deg^{-1} for both crystals.

We note in conclusion that since the thermal self-focusing or defocusing is connected with inhomogeneous heating, the influence of the thermoelastic stresses, accompanying the inhomogeneous heating, which is considered in this article, must be taken into account in all problems involving thermal interactions in solids.

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SUSCEPTIBILITY AND HEAT CAPACITY OF A METAL PLATE

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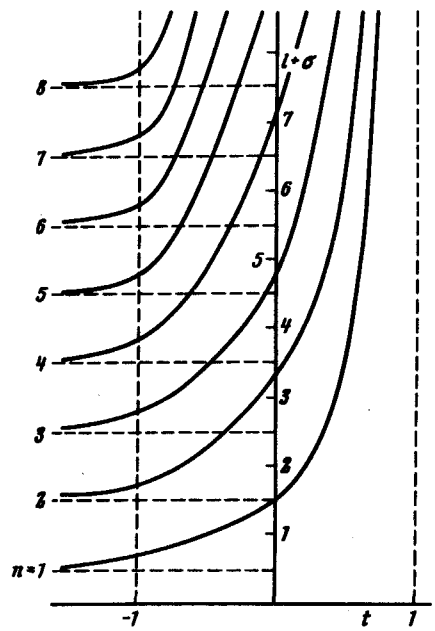
Submitted 7 January 1970
ZhETF Pis. Red. 11, No. 3, 181 - 185 (5 February 1970)

It is well known at present that in a magnetic field H parallel to the surface of a metal there exist, besides the volume Landau levels, also surface magnetic levels (SML). They were first observed by Khaikin [1], who investigated the oscillations of surface impedance. The nature of these oscillations remained unexplained until the publication of the paper by Nee and Prange [2], in spite of the fact that I. Lifshitz and Kosevich [3] investigated the quantization due to the presence of the metal boundary even earlier, in connection with the de Haas - van Alphen effect.

The present paper is devoted to the contribution of SML to the thermodynamic properties. For simplicity, we consider a metal occupying the half-space $x > 0$, choose the z axis along the magnetic field, and assume the electron spectrum to be quadratic and isotropic. The SML are characterized by the following quantum numbers: the number $n = 1, 2, \ldots$, the tangential projection of the electron momentum $\{p_y, p_z\}$, and the spin quantum number $\sigma = 1/2$. The dependence of $\varepsilon_{n\sigma}(p_y, p_z)$ on p_y is shown in the figure. When $p_y < -(2m\varepsilon^{(s)} - p_z^2)^{1/2}$, the distance from the surface to the center of the classical orbit exceeds the Larmor radius R, the electron does not collide with the surface, and the SML have an exponentially small deviation (with respect to p_y) from the Landau levels. The region $|p_y| < (2m\varepsilon^{(s)} - p_z^2)^{1/2}$ corresponds to orbited that intersect the surface, and when $p_y > (2m\varepsilon^{(s)} - p_z^2)^{1/2}$ the entire orbit is located outside the metal and there are no SML. A feature of the spectrum is that all the levels with numbers $n < \varepsilon_F/\hbar\Omega$, where $\Omega = eH/mc$ (the electron charge is e) intersect the Fermi level ε_F. Because of this, the contribution $M^{(s)}$ of the SML to the magnetic moment exceeds, under certain conditions, the usual magnetism $M^{(v)}$ of the conduction



Spectrum of surface magnetic levels $\epsilon^{(s)}(p_y, p_z)$. $l = (\epsilon^{(s)} - p_z^2/2m)^{ng}/\hbar\Omega$, $t = p_y(2m\epsilon^{(s)} - p_z^2)^{1/2}$, $\sigma = \pm 1/2$