amounting to several units, when the variation of the adhesion energy as a function of distances between the crystal ions experiences a discontinuity at the maximum value of this energy.

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EPR IN RUBY IN A CONSTANT ELECTRIC FIELD WITHOUT A MAGNETIC FIELD

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The energy levels of ruby Cr^{3+} ions, in the absence of an external magnetic field and with an electric field turned on, are described by a spin Hamiltonian

$$\hat{H} = D[\hat{S}_z^2 - \frac{1}{3}s(s+1)] + \sum_{i}\sum_{j\leqslant k2}\frac{1}{}R_{ijk}E_i(s_j s_k + s_k s_j), \tag{1}$$

where $s = 3/2$, $D = -5746$ MHz [2], and R is a tensor having the five independent components R_{111}, R_{222}, R_{333}, R_{123}, and R_{113}. The coordinate axes are those used in [1]. In particular, the z axis coincides with the crystal c axis.

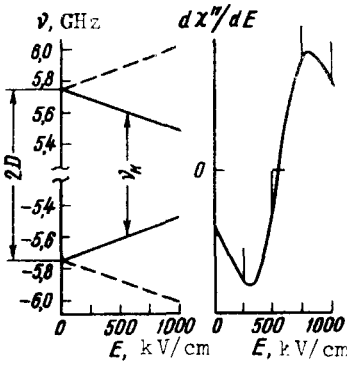
It is seen from (1) that the frequency ν of the transition between two Kramers doublets depends in general on the magnitude and direction of the external electric field E. Regarding the second term in (1) as a perturbation of the first, we obtain, accurate to first order in perturbation theory,

$$\nu = 2|D| \pm 3|R_{333}|E_z. \tag{2}$$

The two signs in (2) correspond to the two non-equivalent positions of the Cr^{3+} ion, which are related by the inversion transformation. Figure (a) shows the energy levels of the Cr^{3+} ion vs. the field E. The dependence of the level positions on the electric field makes it possible to observe the EPR line in a zero external magnetic field by sweeping the external electric field.

The experiment aimed at observing such a line was carried out with a direct-amplification EPR spectrometer with a klystron operating in the 11 - 12 GHz range. To increase the sensitivity, the electric field was modulated at 680 Hz frequency (the modulation amplitude could be varied). The signal was amplified with a narrow band amplifier and recorded with an automatic plotter after synchronous detection at the modulation frequency.

A ruby sample with chromium concentration ~0.5% was cut in the form of a plate 13 x 8 x 0.2 mm with the cutting plane perpendicular to the c axis. The high-voltage source could deliver



(a) Energy levels of chromium ions in ruby in a constant electric field (no external magnetic field). Solid lines - upper and lower Kramers doublets for one of the non-equivalent positions of the chromium ions; dashed - for the other non-equivalent position; ν_{osc} - microwave frequency at which the EPR signal shown in the adjacent figure was observed. (b) EPR signal plotted automatically as the electric field was swept from 0 to 1000 kV/cm.

up to 20 kV, so that the maximum electric field intensity in the sample could reach 10^6 V/cm. Electrodes transparent to microwaves were deposited directly on two surfaces of the sample, which was placed on the axis of a cylindrical H_{011} cavity. The voltage applied to the sample was varied smoothly from 0 to 20 kV within several minutes.

Figure (b) shows one of the obtained EPR signals. Owing to the modulation of the electric field and the synchronous detection, the signal was recorded in derivative form. In this experiment the frequency of the microwave oscillations was 11206 MHz. The center of the EPR line corresponds to an electric field 548 kV/cm. From (2) we can determine directly that $R_{333} = 0.173 \pm 0.006$ MHz per kV/cm, which agrees within the limits of experimental accuracy with the value obtained in [1]. The width of the EPR line at the points of maximum slope is ~500 kV.cm or, according to (2), 270 MHz. The position of the center of the line in the electric field varies with the microwave frequency, as follows from (2). The EPR line shown in Fig. (b) has a Lorentz shape.

The width and shape of the EPR line is apparently determined by the distributions of the values of the parameter D in the crystal [3]. The half-width obtained by us for the EPR line corresponds to the half-width of the distribution curve of D in the crystal, which is equal to 135 MHz. This is much higher than that obtained from an analysis of the causes of the broadening of ordinary EPR lines in ruby [3]. The difference may be due to the fact that our experiment was carried out on samples having much higher concentrations and a very uneven distribution of the chrome ions in the crystal.

In conclusion we note that with the aid of the proposed procedure it is possible, in particular to determine directly the constant D. To this end it is necessary to find the resonant field for several values of ν. The constant which we have obtained in this manner is close to the published value.

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DESTRUCTION OF TRANSPARENT MATERIALS BY LASER RADIATION. FORMATION OF GAS BUBBLES AND WEDGING OF THE MATERIAL BY GAS PRESSURE.

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In most cases the region in which transparent materials are damaged by focused laser radiation is an aggregate of cracks [1-3]. There are two points of view concerning the damage mechanism: (1) The cracks are produced exclusively under the influence of hypersonic waves generated in conjunction with stimulated Mandel'shtam-Brillouin scattering [4]. (2) The damage is the consequence of light absorption accompanied by formation of high-temperature centers [5]. Neither theory nor experiment can determine uniquely as yet the role (and character of interaction) of these two mechanisms.

We present here the results of experiments with materials of the organic-glass type (polymethylmethacrylate, polystyrene). The experiments offer evidence that high-temperature centers and high-pressure centers are produced in the form of gas bubbles, the expansion of which leads to wedging of the material and to formation of cracks.

Typical high-speed photographs of the damage process in a polystyrene sample are shown in Figs. a and b. From Fig. a we see that, within 30 μsec following the start of generation, two glowing spots were produced in the focal regions - these are high-temperature centers. The ends of the samples are outside the borders of the frame. The glow was photographed through a lateral surface of the sample, at 90° to the beam direction. Of the two bright points on the frame marked a, 20 μsec, the right-side one coincides with the location of the focal point. After 60 μsec, these two points have already inititated a crack (whose form recalls the point of a lance). By that time there have also been produced (closer to the lens) three new bright points. In the succeeding frames we see how a dark cavity - made up of cracks - grows in this location. The damage grows opposite to the beam direction (indicated by the arrow). The linear dimensions of the cracks cease to grow after ~300 μsec (pulse duration = 800 μsec). The last frame shows the final damage.

That the cracks become wedged apart by heated gas is convincingly demonstrated by the next series of photographs (Fig. b). In this experiment the focal point and the photography conditions were chosen such as to make the crack emerge during its growth on the photographed lateral surface of the sample (instant 120 μsec after the start of generation, point "T" with arrow). We see how a jet of gas struck out through the produced opening (the gas cloud is marked by "O" and an arrow). The escape of gas (slight haze) could be observed