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1) We note that the use of this crystal makes possible the construction of parametric light generators in the 0.4 - 0.8 μ band.

2) The lines at frequencies $\omega_{1,2}$ split in turn into doublets spaced by ~ 70 Å, owing to the excitation of several modes.

INDUCED MANDEL'SHTAM-BRILLOUIN SCATTERING IN SINGLE-CRYSTAL QUARTZ AT TEMPERATURES 2.1 - 300°K

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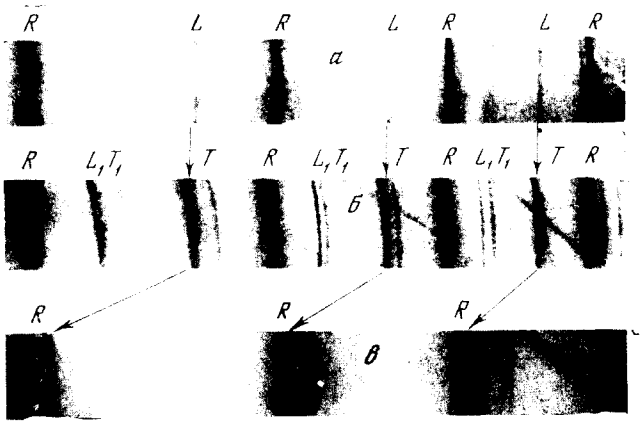
The following effects were observed in induced Mandel'shtam-Brillouin scattering (IMBS) in single-crystal quartz: a strong increase in the shift of the Stokes component, due to the quasilongitudinal hypersonic wave, as the temperature was lowered from 80 to 2.1°K; occurrence of a Stokes component of IMBS due to the quasitransverse wave at 80°K and a difference in the character of the damage to the single crystal in the focused laser beam at different temperatures and for practically constant light-pulse power. The investigations was made with a previously-described installation [1].

The giant light pulse from a ruby laser, of ~250 MW power, was focused with a lens (f = 5 cm) onto the interior of the crystal sample, which was either at room temperature or placed in a cryostat filled with liquid helium or liquid nitrogen. All crystal samples were cut from a single block of Brazilian quartz. The exciting light was guided along the optical axis of the crystal (Z axis) [1], and the scattered light was observed at a scattering angle 180°. The dispersion region of the Fabry-Perot etalon was 2.5 cm. Reproductions of the IMBS spectrum are shown in Fig. 1. The table lists the frequency shifts $\Delta\nu$ of the Stokes component. $\Delta\nu$ doubles in the temperature interval 80 - 4°K [2] and continues to increase with decreasing temperature.

Temperature dependence of $\Delta\nu_E$ in single-crystal quartz

T, °K	2.1	2.4	4.3	80	293
$\Delta\nu_{long}$, cm^{-1}	2.30 ± 0.02	1.97 ± 0.02	1.88 ± 0.02	0.93 ± 0.01	0.93 ± 0.01
$\Delta\nu_{transv}$, cm^{-1}	-	-	-	0.65 ± 0.01	-

Ganapol'skii and Chernets [2] and Bomel and Dransfeld [3] have established that no essential change in sound velocity occurs in a quartz crystal in the temperature interval 300 - 4.2°K.



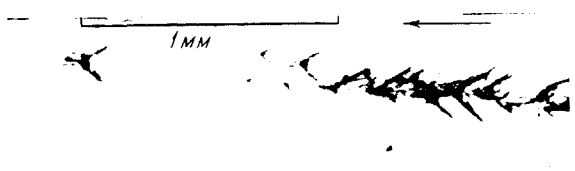


Fig. 2. Microphotograph of the damaged section in the single-crystal quartz at 2.1°K.

Fig. 1. Spectrum of induced Mandel'shtam-Brillouin scattering in single-crystal quartz at different temperatures. The arrow indicates the change in position of the Stokes component of the IMBS. a -- t = 293°K, R -- ruby emission line, L -- longitudinal component; b -- t = 80°K, T = transverse component of IMBS, L_1 and T_1 -- components of repeated IMBS. Electric field of the light wave is parallel to the X axis; c -- t = 2.1°K.

Therefore, in order to explain so large an increase in the frequency, $\Delta\nu = 2n\varphi/c$ ($\varphi = 180°$) [4], it must be assumed that under the conditions of our experiment the refractive index n and the speed of the hypersound v change noticeably under the influence of the strong electric field of the light wave at low temperatures.

The speed of sound v can be estimated from the expression for the free energy of an isotropic dielectric in a static field [5] [3]. It is also easy to estimate the effect produced by striction pressure on the change of the refractive index n (orientational effects are assumed small and are disregarded). It follows from these estimates that

$$\frac{\Delta\nu_E}{\Delta\nu_0} \simeq \left\{1 + \frac{1}{2n_0^2}\left(\rho\frac{\partial\epsilon}{\partial\rho}\right)^2 \beta_s \frac{E^2}{8\pi}\right\}\left\{1 + \rho\frac{\partial\epsilon}{\partial\rho}\beta_s\frac{E^2}{8\pi}\right\}^{\frac{1}{2}} \qquad (1)$$

where $\Delta\nu_0$ and $\Delta\nu_E$ are the shifts of the IMBS components in the absence and presence of a field.

Under the conditions of our experiments, the field intensity in the geometrical focus (without self-focusing) is $\sim 2 \times 10^7$ V/cm.

If we assume that the change $\Delta\nu$ on going to the temperature 4.2°K ($\Delta\nu_E/\Delta\nu_0 \sim 2$, Table 1) is determined only by the action of the electric field, then it follows from (1) that this field should be $\sim 10^9$ V/cm, and at 2.1°K it should be $\sim 2 \times 10^9$ V/cm. Some increase in the field intensity on going from higher to lower temperatures can be expected because of the different character of the self-focusing [6]. However, for fields $\sim 2 \times 10^9$ V/cm Eq. (1) ceases to hold true, and multi-photon absorption becomes so appreciable that the crystal may become opaque. Therefore the influence of the electric field on the refractive index and the speed of the hypersound are apparently not the only cause of the observed appreciable increase of $\Delta\nu$ at low temperature.

In our experiments we observed a strong difference in the outward appearance of the damage in the single crystal of quartz at different temperatures.

On going from room temperature to 2°K, a change takes place in the form of the damaged regions, principal among which is the great decrease in the diameter of the damaged regions at low temperature. A section of the trace of damage at 2°K is shown in Fig. 2. It is important to note that at 80°K under our conditions the crystal was not damaged at all, even though the giant-pulse light was focused dozens of times at the same power as in the other cases, and IMBS was observed in each case.

If we adhere to the point of view that the acoustic phonons play the decisive role in the crystal damage [7], or play the role of a "primer" in this process [8], then we can attempt to explain the difference in the character of the damage in the following manner. At 80°K the abosrption of the hypersound is somewhat smaller than at 300°K, and this decrease is apparently sufficient to produce IMBS without damaging the crystal.

When the temperature is lowered to 4.2°K, the absorption coefficient becomes even smaller. If damage is still observed in this case, it can be attributed to the strong narrowing of the light channel, and consequently the increase in the intensity of the light and the hypersound.

In the case under study, the amplitude of the sound is quite large, and therefore the available data for the absorption coefficient [3] cannot be used for quantitative estimates.

In conclusion we are grateful to L. V. Keldysh and Yu. P. Raizer for useful remarks made during the discussion of the results, and to O. B. Vol'skaya, M. A. Vysotskaya, and V. P. Zaitsev for help with the work.

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[1] The direction along the optical axis was established with the unaided eye and could deviate from it by ~0.5 - 2°.

[2] For technical reasons we were unable to narrow-down the temperature interval in which the increase of $\Delta\nu$ takes place.

[3] The general problem of the effect of the electric field on the speed of sound is

being solved by L. V. Keldysh independently of this work, and we hope to be able to compare soon our results with his calculation.

ON THE SIGN OF THE CHANGE OF THE CHARGE RADIUS OF THE Sn^{119} NUCLEUS

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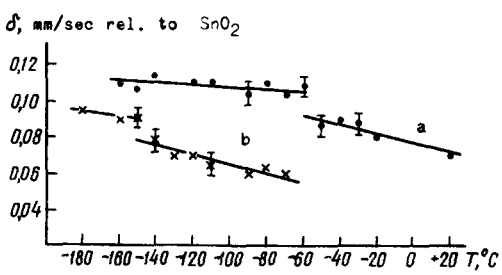
It was found in [1,2], as a result of an analysis of the experimental data on the chemical shifts (δ) in Mossbauer absorption spectra of tetrahalogenides of tin, that the relative change of the charge radius of Sn^{119} on going from the ground state to the first-excited state is positive, i.e., $\Delta R/R > 0$.

A more careful analysis of the sign of the change of the Sn^{119} charge radius [3-5] has shown later that the assumptions made in [1,2], namely that the compound SnF_4 is 100% ionic and that a decisive influence on the electron density in the nucleus is exerted only by the external S electrons, is apparently unfounded. The authors have then concluded on the basis of the data on the tetrahalogenides of tin that $\Delta R/R < 0$ for Sn^{119}.

We used the nuclear-gamma-resonance spectroscopy method to investigate the behavior of $Ba(Ti, Sn)O_3$ solid solutions in the region of transition from the paraelectric into the ferroelectric state. From an analysis of the data on the temperature dependence of the chemical shift in the absorption spectra of such solid solutions in the transition region, and from a comparison with similar data for $Ba(Ti, Fe)O_3$ [6], conclusions can likewise be drawn concerning the sign of the change in the charge radius of Sn^{119}.

The investigation was made with the apparatus described in the paper of Krizhanskii and Kruglov [7]. The source was tin dioxide. The absorber temperature was varied from room temperature to -170°C and was maintained within ±1°C during the experiment.



Shift of center of gravity of resonance-absorption line vs. temperature:
a -- $Ba(Ti_{0.8}, Sn_{0.2})O_3$,
b -- $Ba(Ti_{0.7}, Sn_{0.3})O_3$.

The temperature dependence of the chemical shift in the spectra of the investigated compounds is shown in the figure. At temperatures above -60°C (a) and -150°C (b) the corresponding solid solutions are in the paraelectric phase, which belongs to the cubic central-symmetry point group m3m (perovskite-type structure). In this phase the shift of the center of gravity of the absorption line varies linearly with the temperature, with a slope $(3.0 \pm 1) \times 10^{-4}$ (mm/sec)/deg. This dependence can be readily attributed to the temperature shift due to the quadratic Doppler effect. However, at temperatures -60°C (a) and -150°C (b) a discontinuity sets in and a jump occurs in the value of the chemical shift. The presence of jumps in the temperature dependence of δ