changes after the end of the field development. This may be explained by recognizing that the theory in [6] was developed for resonators that are plane-parallel or nearly so, whereas the laser cavity is not plane-parallel in practice, owing to inhomogeneities in the ruby crystal. It is possible that the most important role is played here by minute knot-like inhomogeneities, and not the general "lenticular" behavior of the crystal considered in [6].

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* This quantity was obtained for one crystal and probably depends on the inhomogeneities of the ruby samples.

## FINE STRUCTURE IN THE SPECTRUM OF THE THERMAL RAYLEIGH LINE WING IN LIQUIDS

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We have discovered in the spectrum of thermal depolarized light scattering (Rayleigh-line wing) a new phenomenon, consisting in the fact that the x-component * of this spectrum is split into two components. The distance between the components of this doublet is much smaller than the distance between the Mandel'shtam-Brillouin components. The phenomenon was observed in the spectrum of light scattered by nitrobenzene and quinoline.

A rather narrow diffuse section of the wing of a number of liquids was also observed earlier on the interference pattern of the spectrum of scattered light [1], but its fine structure, in so far as we know, has been observed here for the first time. This observation was made possible by the use of a gas laser as the source of exciting light. The entire experiment was carried out with the setup described in [2]. The vessel with the scattering liquid was placed both inside and outside the laser cavity.

We have recently called attention to the existence of a narrow and intense Rayleigh-line wing in nitrobenzene. A detailed study of this section in nitrobenzene and quinoline has shown that a doublet is observed in the x-component in these liquids (see the figure), and that the spacing between its components depends on the scattering angle (see the table).

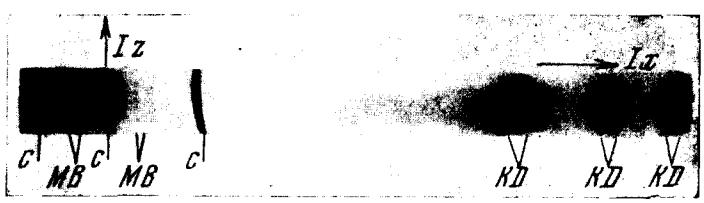
Experiments with nitrobenzene have shown that the doublet components become broader when the temperature is increased.

T a b l e

| Liquid | $t$, °C | $h \cdot 10^2$, poise | $\theta$, °C | $2\Delta\nu_{max}$, $cm^{-1}$ | $f \cdot 10^{-9}$, Hz | $v_T$, m/sec | $\mu \cdot 10^{-9}$, dyne/$cm^2$ |
|---|---|---|---|---|---|---|---|
| Quinoline | 20 | 3.6 | 90<br>120 | 0.078<br>0.093 | 1.2<br>1.7 | 300<br>300 | 1.2<br>1.2 |
| Nitro-benzene | 20 | 2.03 | 90 | 0.043 | 0.64 | 200 | 0.4 |

From our point of view, the observed phenomenon is due to the fact that the light scattered by the anisotropy fluctuations due to shear-deformation fluctuations is modulated by the corresponding Fourier component of the shear deformation or, in other words, by transverse sound satisfying the Bragg condition [1,4,5].

The theory of light scattering by anisotropy fluctuations due to shear fluctuations was developed by Leontovich [4] and Rytov [5] and was described also in [1]. For an exciting light polarized in a plane perpendicular to the scattering plane, the spectral distribution of the x-component of the scattered light is given by




**Interference pattern of light scattered by quinoline in z- and x-polarizations at 20°C. C - central component, MB - Mandel'shtam-Brillouin components, KD - components of the Rayleigh-line-wing doublet in x-polarization.**

$$I_{zx} \sim \frac{A^2}{\mu}\left\{\frac{\Omega^2\tau}{\Omega^2+\tau^2(\Omega^2-\Omega_T^2)^2}+\frac{\tau}{1+\Omega^2\tau^2}\right\}, \qquad (1)$$

where A is proportional to the Maxwell constant [1,4], $\tau$ is the anisotropy relaxation time, assumed to be of the same order as the Maxwellian relaxation time of the shear viscosity, $\mu$ is the shear modulus, $\Omega$ is the frequency reckoned from the fixed frequency, and $\Omega_T$ the frequency of the transverse sound, equal to

$$\Omega_T = 2n\frac{v_T}{c}\omega_0 \sin\frac{\theta}{2}. \qquad (2)$$

The speed of the transverse sound is $v_T = \sqrt{\mu/\rho}$ and the remaining symbols are standard [1].

It follows from (1) that maxima will be observed in the scattered light at frequencies $\Omega_{max} \approx \pm\Omega_T$. Consequently, by measuring $\Delta\nu_{max} = \Omega_T/2\pi c$ we can determine from (2) the speed $v_T$ of the transverse sound at the frequency $\Omega_T$.

Owing to the influence of the second term in (1), the distance $2\Omega_{max}$ between the maxima will be somewhat smaller than $2\Omega_T$. We did not introduce a suitable correction for the speed of sound in this, first investigation, since the exact value of $\tau$ is unknown. An estimate

shows that for nitrobenzene and quinoline the anisotropy relaxation time and the shear-viscosity relaxation time are of the same order with a value $\tau \sim (2 - 5) \times 10^{-11}$ sec. In our case, therefore $\Omega_T \tau \ll 1$ and the correction to the values of $v_T$ listed in the table can reach ~10%. If the explanation proposed here is correct, then the new phenomenon will make it possible to investigate a rather large group of liquids, to measure in them the speed of the transverse sound wave and the shear modulus, to determine the relaxation time from the relation $h = \mu\tau$, and to trace, by varying the angle, the dispersion of the transverse-sound velocity within the possible limits. It is possible that in the case of high-viscosity liquids it will become possible to compare the transverse-sound speed obtained from this phenomenon at $\sim 10^9$ Hz with the transverse-wave speed measured for the same liquid at ultrasonic frequencies.

The first determinations of the transverse-sound speed and the shear modulus from the distance between the fine-structure components of the Rayleigh-line wing are listed in the table. As expected, the shear modulus is larger for the more viscous liquid. Comparison of the obtained values of $\mu$ with the measurements of the limiting shear modulus of the liquid with the larger shear viscosity [6] shows that the values of $\mu$ obtained by us are not surprising.

Measurement of the shear modulus of low-viscosity liquids at $10^9$ Hz entails presently serious difficulties. An investigation of the fine structure of the Rayleigh-line wing uncovers such a possibility for liquids consisting of anisotropic molecules.

In conclusion, the authors are grateful to M. A. Leontovich and S. M. Rytov for a valuable discussion of the results and to V. P. Zaitsev for great help with the work.

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* The scattered light passes through a Wollaston prism oriented so that the photographic plate is exposed simultaneously to the spectra (interference pattern) of the light polarized perpendicular and parallel to the scattering plane (z and x components) [1].