respectively. Expression (3), in particular, indicates that the velocity of the transverse sound in a liquid medium is strongly dependent on the sound absorption.

We did not measure the phase angle in our experiments, but the following conclusions can be drawn.

Measurements in such a setup can yield only the ratio of the absorption to the sound velocity in the liquid medium, but it is possible to obtain the complete information in conjunction with optical experiments.

Recognizing that the sound velocity in experiments with a transverse doublet is determined much more accurately than the absorption, we can state that the absorption given by Stegeman [6] for quinoline is overestimated by at least one order of magnitude. If this is not so, then we must assume an appreciable increase of μ, and consequently also of the absorption, with increasing frequency, with a simultaneous decrease of the velocity of the transverse sound.

The sound velocity in similar experiments cannot be smaller than v_{min} - which undoubtedly is a certain limiting parameter of the liquid:

$$v_{min} = v_{cryst}\frac{\rho_{cryst}}{\rho_{liq}}\,\frac{1 \quad R}{1 + R}. \tag{4}$$

v_{min} = 218 m/sec and 37 m/sec for glycerine and quinoline, respectively (temperature 30°C, frequency 200 MHz).

An estimate of the amplitude losses of transverse sound on the crystal-liquid boundary for the object investigated by Rayleigh spectroscopy, as well as our experiments, show that at this stage there is no experimental technique capable of measuring the absorption and the velocity by a method in which the transverse sound is transmitted through a liquid layer.

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PROPAGATION OF TRANSVERSE HYPERSONIC WAVES IN LOW-VISCOSITY LIQUIDS

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A fine structure of the Rayleigh-line wing was observed in the investigation of the spectrum of light scattered in low-viscosity liquids [1]. This phenomenon was interpreted as being a result of modulation of the scattered light by transverse Debye hypersonic waves propagating in the liquid with relatively low velocities and small absorption. One could therefore hope to excite transverse acoustic waves in low-viscosity liquids at hypersonic frequencies. To this end, we organized experiments in which the transverse hypersonic waves in liquids were investigated by the method of measuring the reflection coefficient of the transverse waves excited, for example, in quartz from a surface of the quartz wetted by the investigated liquid [2, 3].

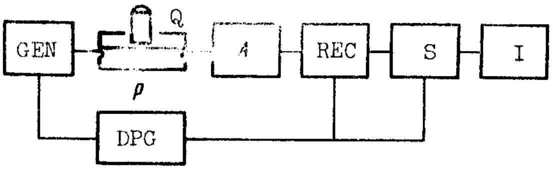

Fig. 1

A block diagram of the setup used for the pulsed hypersonic measurements is shown in Fig. 1. Pulses of fast transverse waves ($V_t = 5.11 \times 10^5$ cm/sec) were excited in a rod of X-cut quartz (Q) placed in a Q-mode coaxial Lamb resonator (R). The resonator ensured appreciable attenuation of the other modes in the quartz. From among the obtained sequence of pulses, we isolated and selected pulses corresponding to the largest number of reflections, whose amplitude A_n was the most sensitive to changes of the reflection coefficient, since $A_n \sim m^n$, where m is the modulus of the reflection coefficient, and n is the number of reflections from the surface wetted by the liquid. We used only pulses in which there were no interference effects indicating simultaneous arrival of relatively weaker longitudinal and slow transverse waves in the quartz. The pulse selection was carried out in a receiver (REC) and strobing attachment (S), controlled by a delayed-pulse generator (DPG) in synchronism with a microwave pulse generator (GEN). The amplitude of the pulse discriminated by this system, after n reflections from the clean quartz surface situated outside the resonator, was measured beforehand by means of an integrator (I). A drop of the investigated liquid was then placed on this surface; the liquid temperature was measured with a thermocouple. The ensuing decrease of the reading of the generator was offset by means of a calibrated attenuator (A). This was the method of measuring the reflection coefficient m.

The described method was used to measure the transverse-wave reflection coefficient at frequencies 500 - 1000 MHz for aniline, quinoline, nitrobenzene, and water. For quinoline at 515 MHz, the measurements were performed in the temperature interval from 2.5 to 111°C. Excitation of the transverse hypersonic waves was also observed in benzene, carbon tetrachloride, and acetone.

To determine the propagation velocity V_ℓ and the absorption coefficient α by this method, it is necessary to measure the coefficient of reflection and the change of phase of the wave reflected from the surface of the quartz wetted by the liquid, and compare it with the phase of the wave reflected from the clean quartz surface. In those cases, however, when $(\alpha V_\ell/\omega) \ll 1$, this change of phase is negligibly small, and by using the value of the reflection coefficient it is possible to calculate the propagation velocity

$$V_\ell = [(\rho V_t)_{\text{quartz}}/\rho_\ell](1 - m)/(1 + m),$$

where ρ and ρ_ℓ are the densities of the quartz and the liquid, respectively.

The experiments on the fine structure of the Rayleigh-line wing corresponding to transverse hypersound in aniline, quinoline, and nitrobenzene indicate that the values of $\alpha V_\ell/\omega$ in them are much smaller than unity. Taking this circumstance into account, we deemed it possible to calculate the transverse-wave velocities in the investigated liquids from the obtained values of the reflection coefficient.

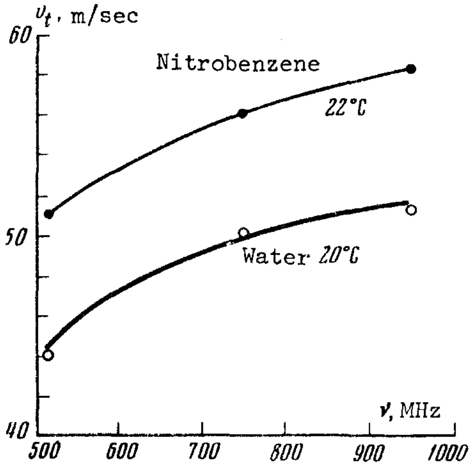

Fig. 2

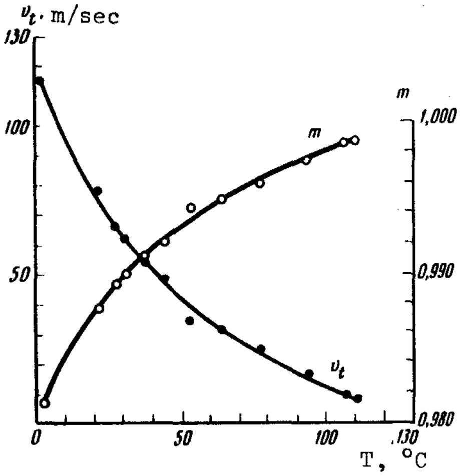

Fig. 3

The obtained transverse-wave propagation velocities for nitrobenzene and water are shown in Fig. 2 as functions of the frequency. When the frequency is varied from 515 to 950 MHz, the velocity of these waves in aniline changed from 74 to 105 m/sec at 22°C and in quinoline from 78 to 110 m/sec at 21°C. The sign of the velocity dispersion and the character of its variation with frequency (Fig. 2) are in qualitative agreement with the results of Maxwell's theory.

Figure 3 shows the temperature dependences of the velocity of the transverse waves in quinoline at 515 MHz. With increasing temperature, the viscosity decreases, and with it the velocity. The values given above for the transverse-wave velocity are accurate within 10 - 20%. It sould also be noted that measurements of the velocities of the transverse waves in the same liquids, carried out using lithium niobate as the radiator, gave velocity values larger by 20 - 30%. Therefore our first results should be regarded as only estimates of the order of magnitude of the velocities of the transverse hypersonic waves in the investigated low-viscosity liquids.

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SELF-FOCUSING AND DEFOCUSING OF SHORT LIGHT PULSES IN MEDIA WITH INERTIAL NONLINEARITY

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1. The subject of this article is an analysis of the features of the propagation of light pulses (or, in the more general case, of optical radiation