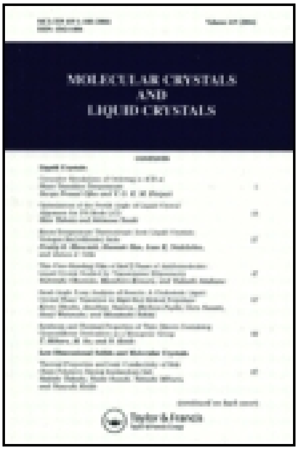

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Anisotropy of Acoustical Parameters and Dynamics of the Nematic Phase in MBBA

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ANISOTROPY OF ACOUSTICAL PARAMETERS AND DYNAMICS OF THE NEMATIC PHASE IN MBBA

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Abstract The results of ultrasound experiments carried out for an oriented sample of MBBA are presented. It is shown that the frequency dependences of ultrasound parameters anisotropy in the frequency range 0,3-10 MHz can be described in the framework of a single relaxation time model.

The experimentally obtained temperature-frequency dependence of ultrasound attenuation anisotropy $\Delta\alpha/f^2$ in the nematic phase of liquid crystals can be described within the framework of generalized hydrodynamics[1], according to which a number of molecular processes can contribute to the value of $\Delta\alpha/f^2$. Particulary, in studies[1,2] the existance of the two independent relaxation processes is proposed for explanation of the temperature-frequency dependence in MBBA of $\Delta\alpha/f^2$. The first of these processes is connected with the critical relaxation of the order parameter, the second-with intermolecular relaxation. At the same time, when describing an absorption coefficient in a nonoriented sample of MBBA[3] the process, atributed to the relaxation of fluctuations of the order parameter was taken into account as well as the relaxation of it.

In this paper we present the results of investigation of anisotropic acoustical parameters of MBBA wich was carried out by the resonator[4] (in the frequency range $0,15 < f < 1,2$ MHz) and the pulse-phase method[5] (for $3 < f < 46$ MHz). Fig.1 presents the temperature dependence of anisotropy of ultrasonic absorption coefficient in MBBA ($\Delta T = T_c - T$, T_c - the clearing point). Fig.2 shows characteristic relaxation curves of the frequency dependence of $\Delta\alpha/f^2$.

The simple phenomenological description of the results shown in fig.2 can be made using the single-relaxation approach:

$$\frac{\Delta\alpha}{f^2} = \frac{A}{1+\omega^2\tau^2} + B \qquad (1)$$

The obtained relaxation parameters τ, A and B are presented in table.

TABLE The relaxation parameters.

ΔT,K	20	15	10	8	6	4	3	2	1
τ, 10^{-9}s	23	22	27	29	37	56	75	77	104
A, $10^{-6}s^2m^{-1}$	89	97	89	79	76	71	68	69	63
B, $10^{-14}s^2m^{-1}$	22	14	16	24	27	34	21	29	14

Fig.3 shows the temperature dependence of relaxation time τ. It should be noted that the values of τ, calculated independently[3] well agree with the values of τ, presented in table. This fact shows that, firstly, there is a similarity between the processes responsible for the behavior of the critical part of absorption coefficient and its an sotropy. Secondly, the fluctuations of order parameter give probably the same contribution to normal and parallel components of

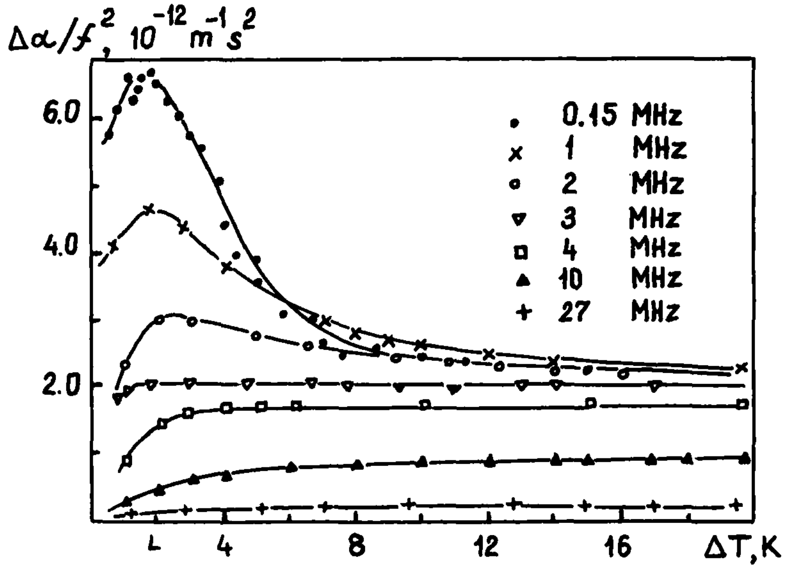

FIGURE 1 The dependence of $\Delta\alpha/f^2$ on temperature; •, ▽, + – our data, ×, o, □, ▲ –[2]

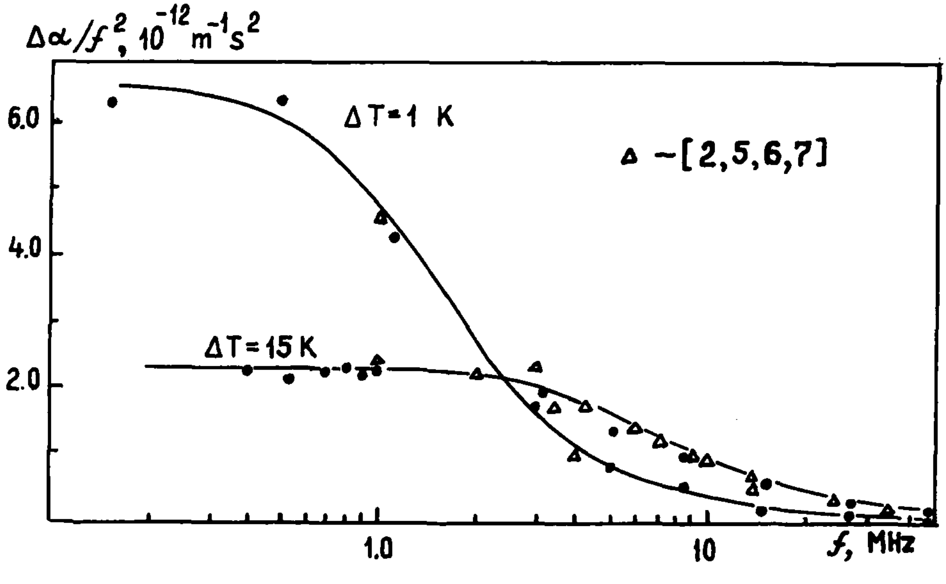

FIGURE 2 The dependence of $\Delta\alpha/f^2$ on frequency.

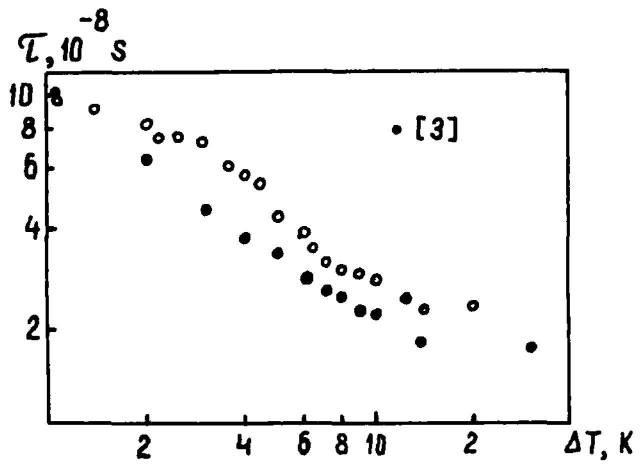

FIGURE 3 The temperature dependence of τ.

absorption coefficient and so, we can make a hypothesis about the isotropy of the fluctuation contribution.

The values of A and τ from the table allow to calculate[1] the anisotropy of ultrasound velocity:

$$\frac{\Delta c}{c} = A \cdot \frac{c}{4\pi^2} \cdot \frac{\omega^2\tau^2}{1+\omega^2\tau^2} \tag{2}$$

The results of our measurement of velocity anisotropy and the calculation of it are presented in fig.4. In the 3 - 8,8 MHz frequency range expression (2) describes the experimental data within experimental error, which also confirmes the possibility of using for this range the single relaxation time model. The systematical exceeding of our experimental data compared with the calculation for 14,7 MHz and 27 MHz can be attributed to the influence of the high frequency process of intermolecular relaxation. The evaluation of relaxation time of this process using the data from fig.4 gives $\tau \sim 6 \cdot 10^{-9}$s (when $\Delta T_c \sim 5$ K), which agrees with the results[8], reported for the nematics with the similar to MBBA end groups.

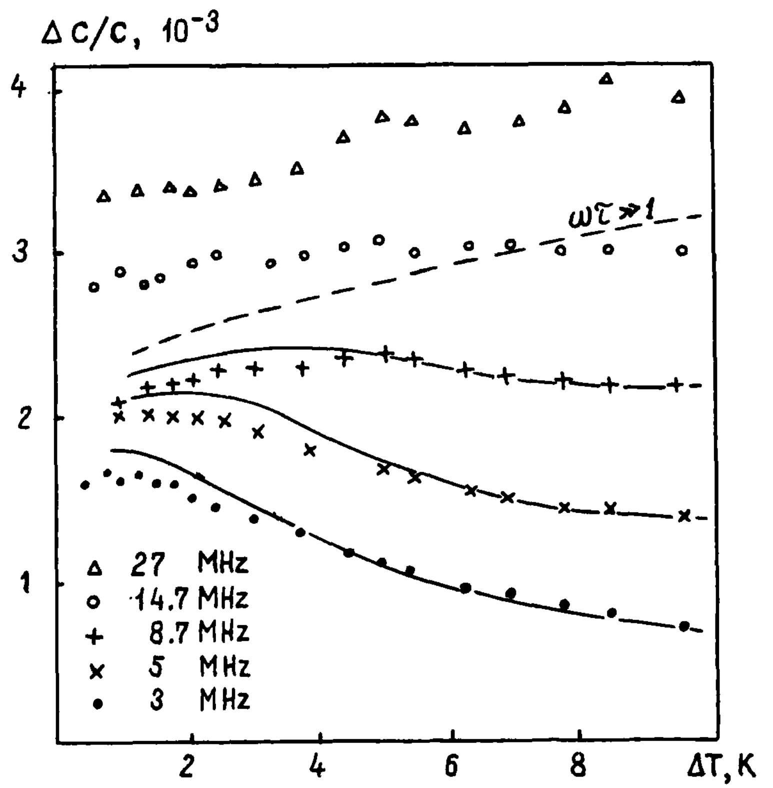

FIGURE 4 The velocity anisotropy; — — - eq.(2).

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