such experiment was carried out, however.

To check on the $\nu_\mu \neq \nu_e$ hypothesis it is desirable to perform an experiment with a proton target (hydrogen bubble chamber) in an antineutrino beam. According to (2) - (4), there should be no meson yield.

[1] M. A. Markov, Neitrino (Neutrino), Nauka, 1964.

[2] A. A. Mukhin, Experiments with High Energy Neutrinos, Voprosy fiziki elementarnykh chastits (Problems of Elementary Particle Physics), AN ArmSSR, Nor-Amberd, 1964.

[3] L. Rozenson, Phys. Rev. 109, 958 (1958).

[4] L. B. Okun', Slaboe vzaimodeistvie elementarnykh chastits (Weak Interaction of Elementary Particles), Fizmatgiz, 1963, p. 72.

[5] R. Plano, Phys. Rev. 119, 1400 (1960).

[6] M. M. Block et al., Nuovo Cimento 23, 1114 (1962).

[7] L. B. Okun', Conserved Vector Current, op. cit. [2].

CHANGE IN THE PROBABILITY OF THE MOSSBAUER EFFECT ON Sn^{119} IMPURITY NUCLEI IN THE FERROELECTRIC PHASE TRANSITION IN $BaTiO_3$

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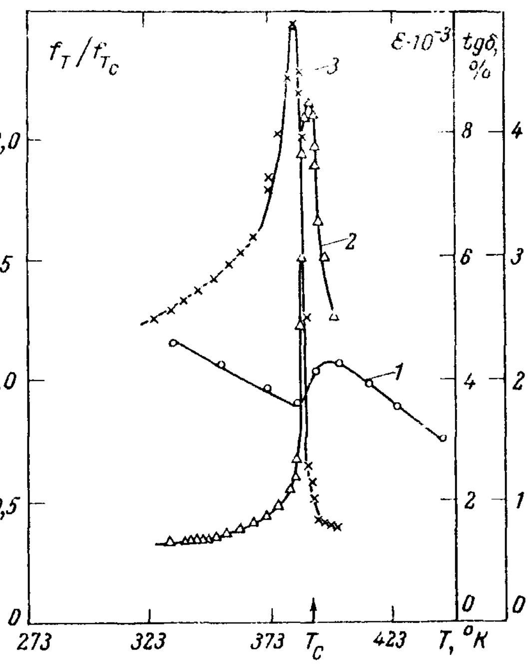
There is at present little information on the change occurring in the parameters of the γ-quantum resonance absorption spectra during phase transitions. Of particular interest is the ferroelectric phase transition in crystals with perovskite structure, where, as shown in several papers [1-3], some normal oscillations of the low-lying transverse optical branch are expected to be unstable. The occurrence of spontaneous polarization in crystals of the $BaTiO_3$ type is attributed to the anomalous decrease in the frequency of the long-wave oscillation of the crystal lattice on approaching the phase-transition point in the para-electric region. The frequency of these oscillations at low values of the wave number, according to Cochran [3], is determined by the relation

$$\omega^2(T) \sim (T - T_C)$$

where T_C is the Curie temperature.

The presence of such an anomalous optical branch, responsible for the occurrence of the ferroelectric states in crystals with perovskite structure, should lead, as shown in [4], to an attenuation of the Mossbauer line intensity in the para-electric region as the Curie point is approached.

We have investigated the temperature variation of the probability of the Mossbauer effect on Sn^{119} impurity nuclei in the $Ba(Ti_{0.99}Sn_{0.01})O_3$ system near the ferroelectric phase-transition temperature. The introduction of so small an amount of tin impurity into barium



titanate does not change its ferroelectric properties noticeably, but at the same time makes it possible to measure the resonance absorption of 23.8-keV γ quanta by the Sn^{119} impurity nuclei. The samples were prepared by standard ceramic technology, using tin oxide enriched with Sn^{119} to 65.1%. The measurements were made with a setup in which the absorber was driven at constant speed by means of a mechanical cam drive. The γ-quantum source was magnesium stannide ~ 18 mg/cm^2 thick.

The resonance absorption spectrum in the ferroelectric region constitutes a weakly resolved doublet with a center of gravity shifted -1.84 ± 0.02 mm/sec relative to Mg_2Sn; in the paraelectric region the spectrum is a somewhat broadened single line. The absorber temperature was monitored by a copper-constantan thermocouple and maintained accurate to ± 5°. The source temperature was constant at 77°K during the course of all the measurements.

The figure shows the temperature dependence of the relative Mossbauer-effect probability (1), of the dielectric constant (2), and of the dielectric loss tangent (3) for the system $Ba(Ti_{0.99}Sn_{0.01})O_3$. The relative probability of the effect was determined from the ratio of the areas of the absorption spectra at the given temperature to the area of the spectrum at the Curie temperature, the value of which (T_C = 390°K) was chosen to correspond to the maximum of the dielectric constant. It is seen from the figure that the relative Mossbauer-effect probability decreases quite sharply on approaching the Curie point from the paraelectric region, passes through a minimum, and then begins to grow with decrease in temperature in the usual manner. The minimum of the probability coincides with the maximum of $\tan\delta$; the maximum of ϵ is near the minimum of the probability and occurs in the region where the latter has a steep descent.

The observed singularity in the temperature dependence of the probability of the Mossbauer effect on Sn^{119} impurity nuclei in the ferroelectric phase transition in barium titanate can be attributed to the already mentioned temperature dependence of the frequency of the anomalous optical branch.

A comparison of our results with earlier measurements [5] confirms the previously advanced hypothesis that the phase transition in solid solutions of the $Ba(Ti_{0.8}Sn_{0.2})O_3$ system is considerably "smeared."

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[1] V. L. Ginzburg, UFN 38, 490 (1949); FTT 2, 2031 (1960), Soviet Phys. Solid State 2, 1824 (1961).

[2] P. Anderson, Physics of Dielectrics (Russian translation), AN SSSR, 1960.

[3] W. Cochran, Phys. Rev. Lett. 3, 412 (1959); Adv. Phys. 9, 159 (1960).

[4] Muzikar, Janovec, and Dvorak, Physica status solidi 3, K9 (1963).

[5] Bokov, Romanov, and Chekin, FTT 7, 1886 (1965), Soviet Phys. Solid State 7, in press.

FINE STRUCTURE OF SPECTRAL LINES OF LIGHT SCATTERED IN CUBIC CRYSTALS

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A study of the modulation of the spectral lines by Debye thermal waves makes it possible to measure the velocity of elastic waves at frequencies $\simeq 10^{10}$ cps. However, although more than 30 years have elapsed since the discovery of the fine structure of the scattered-light lines [1], few such investigations were made for solids [2-7]. In addition, the quality of the obtained spectrograms apparently was too poor to reproduce in print, since such spectrograms were published only in rare cases. Special difficulties were encountered in the registration of the satellites of the spectral lines, connected with the scattering of light by transverse elastic waves. Thus, for example, the tremendous discrepancy between the velocity of the longitudinal elastic waves in ruby, determined from data on light scattering (7300 m/sec) and calculated from the elastic constants of the crystal (11,000 m/sec), was attributed in [4] to the impossibility of resolving in the scattered-light spectrum the spectral-line components modulated by the longitudinal and transverse acoustic waves.

Now that laser light sources have been developed, it became possible to obtain scattered-light spectrograms of such quality, that they permit measurement of the velocity of propagation of longitudinal and transverse elastic waves in crystals within fractions of 1%.

We have investigated for this purpose the fine structure of the spectral lines of scattered light in several cubic crystals: NaCl, KCl, NH_4Cl + 1%Co [1)] and, in addition, in the low-temperature modification of quartz crystals.

Without stopping to describe the source of light (helium-neon laser), we present a diagram of the main working part of the installation (Fig. 1). A thin (cross section area ~0.5 mm^2) needle-like beam of exciting radiation (λ = 6328 Å) was formed with the aid of objective O.

A concave mirror M_1 was placed behind the crystal C to reflect the light back to the crystal and to the laser. By means of fine adjustment of the mirror position we were able to merge the multiple light beams traveling to and fro between this mirror and the laser output