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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

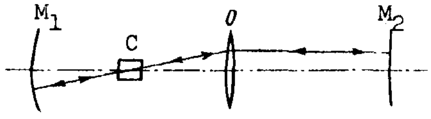

Fig. 1. Diagram showing the illumination of the crystal (the light-beam aperture is greatly exaggerated).

mirror M_2 into a single light beam coinciding with the original one. This experimental procedure made it possible to increase the intensity of the scattered light by a factor of 4 compared with a single passage of the primary laser light beam through the crystal. Moreover, as shown by a photoelectric indicator placed against the opposite (non-working) window of the laser discharge tube, the output power of the laser increased somewhat under these conditions.

The light from the laser propagated along the edge of the cubic lattice of the crystals, and the observations of the scattered light were made along the second edge of the lattice.

The electric vector of the laser light beam was linearly polarized perpendicular to the scattering plane and directed parallel to one of the edges of the cubic crystal lattice. The scattered light was linearly polarized by a Nicol prism in the same manner as the primary light beam in all cases, except when observations were made of scattering by transverse waves in NH_4Cl + Co crystals. In the latter case, the scattered light was polarized with a Nicol prism in the scattering plane. In the case of quartz, no Nicol prism was used in the observation of the scattered light.

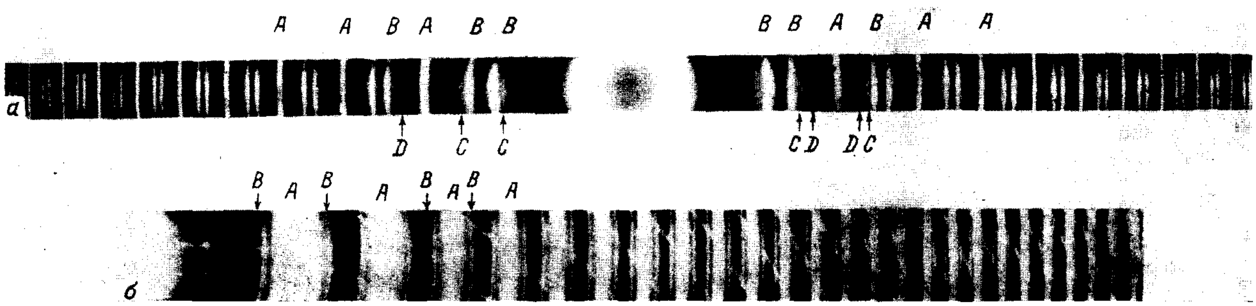

Fig. 2. Scattered-light spectra: a - quartz; b - NaCl; AA - exciting line, BB - the same line modulated by a longitudinal elastic wave, CC and DD - result of modulation by transverse elastic waves.

The spectra of the light scattered at 90° were registered by means of a Fabry-Perot interferometer. The quality of the obtained results can be gauged from the spectrograms of NaCl and SiO_2 in Fig. 2. We note here that when a laser is used the quality of the spectrograms is determined exclusively by the degree of perfection of the available crystal. The results were processed by measuring the positions of the satellites of the Rayleigh line on the spectrogram, so as to exclude sighting on the overexposed images of the undisplaced spectral lines.

The measured satellite displacements ($\Delta\lambda$) and the sound velocities obtained from them are listed in the table. In addition, the table lists the sound velocities calculated from the elastic constants of the crystals [8].

Crystal	Longitudinal elastic wave			Transverse elastic wave		
	Δλ, Å	v, m/sec (measured)	v, m/sec (calculated)	Δλ, Å	v, m/sec (measured)	v, m/sec (calculated)
NH_4Cl + Co	0.228 ± 0.001	4650 ± 25	4430	0.117 ± 0.001	2380 ± 25	2110
NaCl	0.204 ± 0.002	4450 ± 50	4480			
KCl	0.169 ± 0.003	3820 ± 70	3830			

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RELATIVISTIC GENERALIZATION OF SU(6) SYMMETRY AND PRODUCTION OF BARYON RESONANCES

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1. Stodolsky and Sakurai advanced the hypothesis [1] that the principal role in isobar production reactions in meson-nucleon collisions

$$M_1 + B_1 \to B^* + M_2, \qquad B^* \to M_3 + B_2 \tag{1}$$

is played by vector-meson exchange, with the vertex VB*B described, in analogy with the photon, by the magnetic-dipole transition [2]. The consequences of this model were checked most thoroughly in reactions (2) and (3) [3-11]:

$$K^+ + p \to N^{*++} + K^0 \tag{2}$$

$$\pi^+ + p \to N^{*++} + \pi^0 \tag{3}$$

In all cases, with the exception [7] of k_L = 1.1 - 1.27 BeV/c in reaction (3), the observed angular distribution of the isobar decay products were in good agreement with the pre-