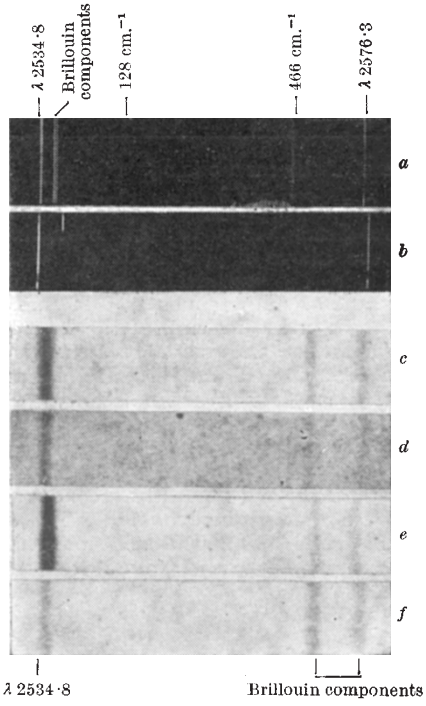
Thermal Scattering of Light in Quartz

USING the λ 2536·5 mercury resonance radiation as exciter and the medium quartz spectrograph with a fine slit, one of us[1] successfully recorded the doubling of the λ 2536·5 line in the spectrum of the light scattered by diamond, the latter itself being completely quenched by a mercury vapour filter. This doubling, as is well known, is of the nature of a Doppler effect arising from the selective reflexion of the monochromatic light by the approaching and receding sound waves of thermal origin assumed to be present in the crystal and travelling in all directions. The components are called Doppler-shifted or Brillouin components. We have now photographed the Brillouin components arising from the thermal scattering of light in quartz using the λ 2536·5 radiation from a water-cooled magnet-controlled quartz arc as exciter and a Hilger three-metre quartz spectrograph having a dispersion of 13·7 cm.$^{-1}$ in the λ 2536 region.

Fig. *a* in the accompanying illustration represents the spectrogram of the scattered light after absorption by a mercury-vapour filter kept at room temperature, taken with a slit-width of 0·01 mm. and an exposure of about one day, while Fig. *b* represents the spectrum of the direct arc. In both cases λ 2536·5 is completely suppressed. The doubling of the exciting line arising from thermal scattering is clearly visible in the spectrum of the light scattered from quartz, while in Fig. *c* the same effect is seen on an enlarged scale. Two of the most intense Raman lines of quartz, namely, 466 cm.$^{-1}$ and 128 cm.$^{-1}$, are also discernible in the scattered spectrum; they are, however, less intense and very much broader than the Brillouin components. Figs. *c*, *d*, *e* and *f* are enlarged photographs of the spectra taken for different orientations of the crystal and for different angles of scattering.



(*a*) Spectrum of the scattered light from quartz. (*b*) Spectrum of the direct arc. (*c–f*) Enlarged photographs of the scattered spectra for four different orientations of the crystal

As is to be expected, the separation of the Brillouin components varies with orientation of the crystal and the angle of scattering. The observed values of the Doppler shifts are in good agreement with those calculated from the known elastic constants of quartz using the well-known Brillouin formula. It may be remarked that Gross[2], working with λ 4358 radiation and a 30-step echelon spectroscope, reported having observed the Doppler components with quartz; but no such convincing experimental evidence was presented by him. Moreover, we have recorded the components without the use of an interferometer.

For any given direction in a crystal, there are, in general, three distinct sound velocities, one longitudinal and two transverse. One should, therefore, expect to observe six Doppler components, three on either side of the exciting radiation. A calculation of the intensities of the components on the basis of Müller's theory[3] shows that the components arising from transverse waves are much less intense than the longitudinal ones. It is therefore not surprising to find that in the spectrograms reproduced here only the longitudinal components have been observed. A detailed paper will be published elsewhere.

R. S. KRISHNAN
V. CHANDRASEKHARAN

Physics Department,
Indian Institute of Science,
Bangalore 3.
Nov. 7.

[1] Krishnan, R. S., *Nature*, **159**, 740 (1947); *Proc. Ind. Acad. Sci.*, A, **26**, 399 (1947).
[2] Gross, E., *Z. Phys.*, **63**, 685 (1930).
[3] Müller, H., *Proc. Roy. Soc.*, A, **166**, 425 (1938).

Optics of Ethylenediamine Tartrate at Elevated Temperatures

ETHYLENEDIAMINE TARTRATE, $C_6H_{14}N_2O_6$, prepared from tartaric acid and ethylenediamine in equimolecular proportions, is a water-soluble piezoelectric compound which crystallizes in the monoclinic system at room temperature.

A preliminary optical and X-ray examination at room temperature has been carried out with the view of studying the crystal structure. These results have recently been reported elsewhere by other workers[1] and, therefore, will not be repeated here, except to summarize data relevant to that which follows.

Specific gravity	=	1·539 ± 0·001 at 18° C.
Approx. monoclinic cell dimensions	a =	8·9 A.
	b =	8·8 A.
	c =	5·9 A.
	β =	105°
Acute bisectrix	=	a
Extinction	$a \wedge c$ =	25° in acute β
Optic axial angle		$2E$ approx. = 40°
Dispersion		strong horizontal $v > r$

Crystals of ethylenediamine tartrate have now been studied with the polarizing microscope at temperatures up to the point at which melting and decomposition take place. It has been found that, as in the case of some other biaxial compounds, for example, selenite, the optic axial angle decreases with increasing temperature. In the case of ethylenediamine tartrate, the optic axial angle becomes zero at a temperature of very approximately 120° C., the crystals then being in a uniaxial negative condition. When the temperature is further increased, the biaxial negative condition is restored and the optic axial angle increases until melting and decomposition occur.