DIFFRACTION OF LIGHT BY SUPERPOSED ULTRASONIC WAVES.

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In his recent book on Der Ultraschall, L. Bergmann has reproduced some striking pictures of the diffraction effects observed when a beam of light traverses normally an ultrasonic sound field produced by a quartz crystal immersed in a liquid and simultaneously excited at two of its harmonics. If $k_1n$ and $k_2n$ are the two harmonics, then beside the diffraction lines due to $k_1n$ and $k_2n$, combinational lines due to $k_1n \pm k_2n$ also appear. A reference to the original paper¹ (1934) showed that he had also obtained similar combinational lines with crystals of different thicknesses, simultaneously excited at two incommensurate frequencies. Early this year, in January, it was thought that a natural explanation for this phenomenon could be provided by the simple theory of Raman and Nath.² Actually Mr. Nagendra Nath in a private communication to Prof. Sir C. V. Raman, had indicated that according to the theory, the consequence of such a superposition of two wave systems would be to give rise to the appearance of new combinational lines, whose number and intensity will vary much with the intensity of either of the original lines. Thus new lines corresponding to $rn_1 \pm sn_2$ will occur, the intensity being given by the expression 

$$J_r^r(v_1) J_s^s(v_2),$$

where $J_r(v_1)$ is a Bessel function of the $r$th order, and $v_1 = \frac{2\pi \mu_1 I}{\lambda}$, $\mu_1$ being the maximum change in refractive index in the liquid, $I$, the length of the light path in the sound field, and $\lambda$ the wave-length of light.

In order to verify these conclusions, it was thought worthwhile to repeat Bergmann’s experiments more systematically, and with different sets of frequencies and intensities. The work had been partly completed when another paper by L. Bergmann³ (1938) appeared, in which besides some of our observations, further extensions of same to diffraction by sound waves set up in glass, have been beautifully recorded. However, we publish herewith some of our pictures, illustrating the effects of varying intensities clearly. In Fig. 1, two different intensities of the first order in (a) were obtained by slight obliquity of incidence, and similarly also for the
second orders in Fig. 2 (a). As is clear from the pictures in Fig. 1, the combination lines come out considerably brighter about the stronger first order on the left. Similarly in Fig. 2 (c), the larger number of combinational lines on the right are due to the additional lines arising out of the second order line. Fig. 3 is reproduced just to illustrate further the large number of combinational lines made visible, when one of the spectra (b) is strongly developed: combinations such as \( n_2 \pm 8n_1, 2n_2 \pm 5n_1 \) can be identified in the picture.

The experiments were all carried out in the usual manner, but with two different crystals excited by separate oscillators, and immersed in xylol vertically at the opposite ends of a square glass trough.

Some theoretical aspects of these combination lines have also been worked out here by Mr. K. N. Rao, but they will not be reproduced here in view of the recent publications of the full papers by Nagendra Nath\(^4\) and also by E. Feus.\(^3\)

The author takes great pleasure in expressing in this connection his gratitude to Prof. Sir C. V. Raman, at whose suggestion this work was taken up before Bergmann's second paper appeared.

**Summary.**

Pictures are reproduced of the diffraction patterns obtained with light that has traversed a system of superposed ultrasonic waves set up in a liquid. Besides the presence of the combinational lines, the pictures clearly show the characteristic manner in which their number and intensities depend upon the intensity of the original spectral orders.

**REFERENCES.**

1. L. Bergmann \( \ldots \) \( Z. \) Hochfrequenz Tech., 1934, 43, 83.
3. L. Bergmann and E. Feus \( \ldots \) Z. Physik, 1938, 109, 1.