INTENSITY OF BRILLOUIN COMPONENTS IN LIGHT SCATTERED BY SOME LIQUIDS*

K. C. MEDHI

OPTICS DEPARTMENT, INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE, CALCUTTA-32

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Plate III

ABSTRACT. The Brillouin components in light scattered by water and acetone have been recorded using an experimental arrangement in which stray light was avoided very carefully It is observed that the intensities of the Brillouin components relative to those of the central components are in agreement with those predicted by the theory of Landau and Placzek.

INTRODUCTION

After the Brillouin components in light scattered by liquids had been first discovered by Gross (1930), Landau and Placzek (1934) calculated the relative intensities of the Brillouin components and the undisplaced component of the Rayleigh line. According to this theory the ratio of the intensity of the undisplaced component and the total intensity of the Brillouin components is given by $(c_p - c_v) : c_v$ and Birus (1938) observed that the experimental results obtained by him in the case of toluene agreed with the theory mentioned above. He also pointed out that the validity of Landau and Placzek's theory could be tested more rigorously by studying the structure of Rayleigh line due to water, because the undisplaced component would be almost absent in this case. He therefore studied the Brillouin components due to water distilled very carefully and concluded that there was no undisplaced component.

Exhaustive investigations on the Brillouin scattering in a large number of liquids were carried out later by Venkateswaran (1942) who also measured the polarisation and intensity of the Brillouin components relative to that of the central component in each case. He used a Fabry-Perot interferometer and a zinc arc as source of monochromatic light. He found that in the case of many liquids including water and acetone the undisplaced central component was too strong to be explained by the Landau-Placzek theory.

The cause of this discrepancy between the experimental results and those predicted by Landau-Placzek theory was investigated later more carefully by

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Rank *et al* (1948) who used a Fabry-Perot etalon 10 cm in diameter and a three-prism spectrograph of high light gathering power. They investigated the intensities and polarisation of the Brillouin components due to ethyl alcohol, acetone and water. They concluded from the results obtained by them that the results were in agreement with those predicted by Landau-Placzek theory. They further pointed out that the discrepancy observed by previous workers was due to insufficient resolving power of the instrument used by them and to the presence of some percentage of stray light in the scattered light. More recently, Febelinskii (1956) found the central component to be too strong to be accounted for by Landau-Placzek theory in the case of a few liquids, but in the case of water it was almost absent.

It is, however, very difficult to eliminate stray light and it was therefore thought worthwhile to set up a suitable arrangement for the study of Brillouin effect in a large number of liquids eliminating stray light to find out whether Landau-Placzek theory can explain the observed facts The preliminary results obtained in the case of acetone and water are discussed in the present paper.

EXPERIMENTAL

The liquids studied were distilled repeatedly under reduced pressure direct into the sample tube in order to eliminate dust particles A pyrex tube 4 cm. in diameter and about 40 cm long with a Pyrex disc fused at one end served as the sample tube. Its horn-shaped tail was blackened with dull black paint and a long black tube of diameter 1 cm placed in front of the window allowed only the light scattered by a narrow cone of the liquid inside the tube to reach the focussing lens Two mercury arcs each about 35 cm long, carrying 12 amperes of current and with the electrodes cooled by running water were placed horizontally on the two sides of the sample tube and two wide glass tubes filled with distilled water were used to focus the light on the axis of the sample tube. Two parabolic mirrors were also used to focus the mercury arcs on the tube. Two Soller slits were placed between the sample tube and the two cylindrical lenses to make the direction of incidence approximately perpendicular to the axis of the sample tube. The deviation was, however, about 12 degrees on each side.

A Fabry-Perot interferometer with a spacing of 5.71 mm was used in conjunction with a Hilger two-prism glass spectrograph provided with F/4.5 camera lens to photograph the interference patterns. The 4078Å line of the Hg arc was used to find out the structure of the Rayleigh line. Ilford Special Rapid plates were used to record the spectra. In the case of acetone an exposure of 24 hours was required to record the pattern due to 4078Å line with moderate density, but in the case of water the rings were very feeble even with an exposure of 18

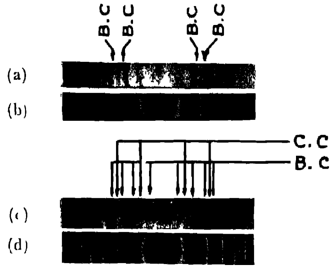

Fig. 1

(a) Brillouin spectrum of water.
(b) Incident λ 4047 A. U of Hg.
(c) Brillouin spectrum of acetone.
(d) Incident λ 4078 A U Hg

B. C —Brillouin component.
C C.—Central component.

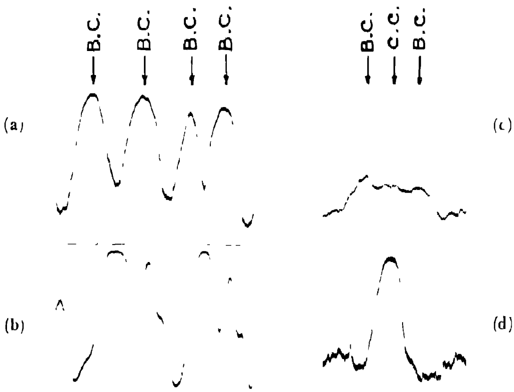

Fig 2 Microphotometric records.

(a) Brillouin spectrum of water
(b) λ 4047 A. U. of Hg.
(c) Brillouin spectrum of acetone.
(d) λ 4078 A U. of Hg

hours. The structure, although not reproducible, was visible on such spectrograms, but a shorter exposure was used to record the rings due to the 4047 Å line with greater density. This line in the incident light showed one very strong component, a second component of about one fifth the intensity of the main component and another much weaker component. As discussed later, the presence of these components did not create much difficulty in interpreting the pattern.

RESULTS AND DISCUSSION

The interference patterns due to 4047 Å line of Hg scattered by water and 4078 Å line scattered by acetone are shown in figure 1 (Plate III) along with those due to these incident lines. The microphotometric records of the rings are reproduced in figure 2.

It can be seen from figure 1(a) that the main component of the 4047 Å line has been split up into two components in the pattern due to water, the intensity at the midpoint between these components being less than 10% of the main peak, and there being no indication of any maximum at this place. Further, the outer one of the two components of the doublet into which each main peak splits up is broader than the inner one, because the two components of the strong satellite fall on either side of this component. The curve thus demonstrates that the central undisplaced component in the case of water has an intensity less than 10% of the Brillouin components.

Figure 2(*d*) and 2(*c*) show that each ring due to the incident 4078 Å line is split up in the light scattered by acetone into three components all of which are of about the same intensity, the central component being slightly weaker. Thus the ratio of the intensity of the central component to the sum of the intensities of the two Brillouin components is about 0.45 in this case. This is in fair agreement with the ratio 0.42 reported by Rank *et al* (1948) and is much less than the value 0.79 reported by Venkateswaran (1942). The high intensity of the central component observed by Venkateswaran (1942) is probably due to presence of stray light. He studied the light scattered backwards and as the background was directly illuminated by the incident light probably the background was not perfectly black.

The results obtained in the present investigation show that it has been possible to eliminate the stray light almost completely. The investigation is therefore being extended to other liquids for which the central component has been found by Venkateswaran (1942) to be too strong to be accounted for by the Landau-Placzek theory in order to find out whether the discrepancy in those cases also is due to presence of stray light.

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