LIGHT-SCATTERING AND OTHER ALLIED PHYSICAL PROPERTIES OF ORDINARY AND HEAVY WATER.

By S. Bhagavantam

AND

B. Sundara Rama Rao.

(From the Department of Physics, Andhra University, Waltair.)

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1. Introduction.

About 50 grms. of heavy water is used in these experiments. It is supplied by the Norsk Hydro-Elektrisk Kvælst ofaktieselskab, marked 99·2 per cent. pure and density $d_4^{20} = 1 \cdot 1049$. The refractive index as measured by us on an Abbe Refractometer at 30° C. is 1·3278 which may be compared with 1·3276 given by Luten.[1] The liquids have been thoroughly purified by repeated distillation in evacuated and sealed double bulbs.

2. Experimental.

Compressibilities of H_2O and D_2O.—The compressibilities of both heavy and oridnary water have been measured at the laboratory temperature with a piezometer similar to that designed by Tyrer[2] and recently employed by Dakshinamurti.[3] The adiabatic compressibilities so obtained have been corrected for the compressibility of the glass of the piezometer. The isothermal compressibilities are then derived by making use of the well-known thermodynamic relation

$$\beta_T = \beta_\phi + \frac{T\left(\frac{\partial V}{\partial T}\right)^2 \times 1 \cdot 013 \times 10^6}{J\, VC_p}$$

where β_T and β_ϕ are respectively the isothermal and adiabatic compressibilities, V the specific volume and C_p the specific heat at constant pressure. In the above calculation, the specific volume, its rate of variation and the specific heat for the two liquids are taken from the existing literature.

Measurement of Depolarisation.—The liquids after being repeatedly distilled in vacuum are contained in small bulbs which are immersed in a rectangular glass cell filled with water. Sunlight is focussed into the

[1] *Phys. Rev.*, 1934, **45**, 161.

[2] *Jour. Chem. Soc.* (Lond.), 1914, **105**, 2534.

[3] *Proc. Ind. Acad. Sci.*, 1937, **5**, 385.

bulbs with the help of a high quality photographic lens. The depolarisation is measured visually by the usual Cornu method. The results given here which represent the mean of several observations are corrected for convergence in the incident beam.

Intensity of Transversely Scattered Light.—The intensity of the scattered light has been measured spectroscopically by photographing the tracks in the two liquids under identical conditions. Light from a mercury point source lamp is condensed on to the ordinary water bulb by a lens and the light scattered in a perpendicular direction is condensed by another lens on to the slit of a two-prism glass spectrograph. A wide slit is used and λ 4358 has been photographed with a suitable exposure. The bulb is then replaced by that of heavy water without altering anything else and λ 4358 is again recorded on the plate giving the same time of exposure. During the exposures the mercury lamp is run on a battery and the current is kept constant.

Intensity marks are taken on the same plate by the method of varying slit widths and the relative intensities in D_2O and H_2O are obtained by microphotometring the two patches and the intensity marks in the suitable region.

3. *Results.*

Results are given in the last column of the following table. β_T and β_ϕ obtained in the case of H_2O are in good agreement with those reported earlier by Tyrer for this liquid.

Liquid	Temp.	$\beta_\phi \times 10^6$	$\frac{\partial V}{\partial T}$	V	C_p	μ_D	$\beta_T \times 10^6$	100ρ	I Cal.	I Obs.
D_2O	29·5	42·0	$0\cdot0_3277$*	·9123*	1·003*	1·3278	42·6	6·4	1·8	1·8
H_2O	29·2	45·9	$0\cdot0_3304$*	1·00434*	0·9979*	1·3320*	46·6	6·2	2·0	2·0

4. *Discussion of Results.*

The intensity of the transversely scattered light in a liquid is given as

$$I_1 = I_0 \cdot \frac{\pi^2}{2d^2} \cdot \frac{RT\beta_T}{N\lambda^4} (\mu^2 - 1)^2 \frac{6 + 6\rho}{6 + 7\rho}$$

*1 V. Slott and Philip H. Bigg, *I.C.T.*, 3, 24.
2 Tyrer, *Jour. Chem. Soc.* Lond., 1914, **105**, 2534.
3 Jaegar and Steinwehr, L. B. Tabellen.
4 Flatow, L. B. Tabellen.
5 Lewis and Macdonald, *Jour. Amer. Chem. Soc.*, 1933, 55, 3057.
6 R. S. Brown, Barnes and Maass, *Can. Jour. Research* 1935, 13, section A. 167–169.
7 D. B. Luten, *Phys. Rev.*, 1934, **45**, 161.

where the various symbols have their usual significance. From this we have

$$\frac{I_1}{I_2} = \frac{(\beta_T)_1}{(\beta_T)_2} \cdot \frac{(\mu_1^2 - 1)^2}{(\mu_2^2 - 1)^2} \cdot \frac{6 + 6\rho_1}{6 + 6\rho_2} \cdot \frac{6 - 7\rho_2}{6 - 7\rho_1}. \tag{3}$$

The value given in the table under column 10 for D_2O has been calculated from the above equation assigning an arbitrary value 2 for H_2O. This is in good agreement with the value observed on the same basis and given in the last column.

It may also be noted that the adiabatic and isothermal compressibilities in each of the cases are nearly the same and the ratio of specific heats for heavy water is therefore very nearly unity as in the case of ordinary water.

5. *Summary.*

With a view to compare the intensities of the transversely scattered light in ordinary and heavy water, the adiabatic compressibility and depolarisation have been measured at the laboratory temperature. The isothermal compressibility is calculated with the help of the thermodynamic relation and the figures show that the relative scattering powers of D_2O and H_2O should be as 1·8 : 2. This is in good agreement with the ratio obtained experimentally by photographing the tracks of the transversely scattered light using the λ 4358 radiation from a mercury point source lamp. Ratio of β_T to β_ϕ in heavy water is very nearly unity as in the case of ordinary water.