

The data for the last three substances are in reasonable agreement with those obtained in their liquid states.<sup>2</sup> It is seen that all the first three compounds show an absorption band in region C. In every case the band is very strong. The maximum of the band is not constant but shows definite shift from compound to compound. These and other considerations rule out the apparent possibility of the band being due to a common impurity. On the other hand they indicate that this absorption is to be connected with the common link, *viz.*, the *p-p* linkage between S and Cl, which all these molecules possess. The absorption spectrum of  $\text{SCl}_2$  is analogous to that of  $\text{OCl}_2$ .<sup>3</sup> The slight maximum in the region A at 5165 is doubtful and may after all be fortuitous, due to reflection losses in the intensity of the continuous beam. If this is so, region A is just a continuation of the absorption in region B brought about by increase in pressure.

Very often absorption bands due to  $\text{SO}_2$  present themselves in the spectra of all of these molecules but they can be avoided with due precautions. The general appearance of these bands on the plates is not always the same and varies with different pressures of the vapours of the accompanying molecules. Actual measurement, however, proves that these bands are due to  $\text{SO}_2$ . In particular the band system referred to in our previous communication is now definitely traced by us to  $\text{SO}_2$ . Details will be published shortly.

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#### On the Ratio of the Temperature Coefficients of Surface Tension and Density.

"MEASUREMENTS have shown that . . . there is marked parallelism between the temperature coefficient of surface tension . . . and the coefficient of expansion. The greater the latter, the greater also is the decrease in surface tension per degree, and the ratio

$$\frac{\text{temperature coefficient (of surface tension)}}{\text{coefficient of expansion}}$$

is approximately the same—between 2 and 3

<sup>2</sup> *Zeit für Physikalische Chemie* (B), 1931, 14, 219.

<sup>3</sup> *Ibid.*, 1931, 15, 127.

—for a very large number of liquids."<sup>1</sup> No formal proof of this observation appears to have been put forward so far. A simple proof based on Laplace's theory of Capillarity is therefore given below.

Laplace assumes that the range of molecular forces is the same for all bodies and that at equal distances the force is proportional to the density of the substance, thus implying that the function  $\psi(z)$  is the same for all bodies.<sup>2</sup> This hypothesis, though leading to results incompatible with experiments on interfacial tension, can however be assumed to hold for the same liquid at different temperatures. From Laplace's theory we obtain for the surface tension,  $T$ , of a liquid that

$$T = \frac{1}{2} \sigma^2 \int_0^{\infty} z\psi(z) dz \quad \dots \quad (a)$$

where  $\sigma$  is the density of the liquid. Assuming, by our hypothesis, that  $\int_0^{\infty} z\psi(z) dz$  does not vary with temperature,  $\theta$ , we get

$$\frac{dT}{d\theta} = \sigma \frac{d\sigma}{d\theta} \int_0^{\infty} z\psi(z) dz \quad \dots \quad (b)$$

Dividing (b) by (a),

$$\frac{1}{T} \frac{dT}{d\theta} = 2 \frac{1}{\sigma} \frac{d\sigma}{d\theta}$$

which proves that the required ratio is equal to 2, because  $\frac{1}{\sigma} \frac{d\sigma}{d\theta} = -\frac{1}{v} \frac{dv}{d\theta}$ , where  $v$  is the volume of the liquid. This ratio obtained by Laplace's theory is in close agreement with the experimental observation that it lies between 2 and 3.

The fact that the observed value is always greater than 2 is significant and can be accounted for by assuming that,  $\psi(z)$  remaining the same, the range of molecular attraction,  $c$ , varies with temperature. It follows that

$$\frac{dT}{d\theta} = \sigma \frac{d\sigma}{d\theta} \int_0^c z\psi(z) dz + \frac{1}{2} \sigma^2 \int_c^{c+\frac{dc}{d\theta} d\theta} z\psi(z) dz$$

<sup>1</sup> *Surface Tension and Surface Energy* by R. S. Willows and E. Hatschek, 1915, p. 7.

<sup>2</sup> *Vide Properties of Matter* by J. H. Poynting and J. J. Thomson, 1922, p. 179.

because

$$\int_0^{c+\frac{dc}{d\theta}d\theta} z\psi(z)dz - \int_0^c z\psi(z)dz = \int_c^{c+\frac{dc}{d\theta}d\theta} z\psi(z)dz.$$

Hence

$$\frac{\frac{1}{T} \frac{dT}{d\theta}}{\frac{1}{\sigma} \frac{d\sigma}{d\theta}} = 2 \left[ 1 + \frac{1}{2} \frac{\frac{1}{\sigma} \frac{d\sigma}{d\theta} \int_c^{c+\frac{dc}{d\theta}d\theta} z\psi(z)dz}{\int_0^c z\psi(z)dz} \right]$$

$$= 2(1 + \epsilon)$$

where, according to the experimental results,  $0 < \epsilon < \frac{1}{2}$ . When  $\epsilon = 0$ , it means that

$$\int_c^{c+\frac{dc}{d\theta}d\theta} z\psi(z)dz = 0, \text{ and hence } \frac{dc}{d\theta} = 0, \text{ or there}$$

is no variation of  $c$  with temperature. But when  $\epsilon = \frac{1}{2}$ ,

$$\frac{\int_c^{c+\frac{dc}{d\theta}d\theta} z\psi(z)dz}{\int_0^c z\psi(z)dz} = \frac{1}{\sigma} \frac{d\sigma}{d\theta}.$$

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### Anomalous Magnetic Rotation of Uranyl Nitrate.

IN continuation of the work on magneto-optical rotation<sup>1,2</sup> we have made at the suggestion of Prof. S. S. Bhatnagar, some observations on this property in the case of uranyl salts. It has been observed that uranyl nitrate shows a negative Faraday effect. The molecular magnetic rotation value is 5.2, assuming that of water to be 1, and it is constant over a wide range of concentration.

All known substances showing a negative Faraday effect with the exception of titanium chloride are paramagnetic (though the converse is not true). The result obtained is of particular significance in view of the

<sup>1</sup> Bhatnagar, Mathur and Jain, *Ind. J. Phys.*, 1930, 4, 503.

<sup>2</sup> Bhatnagar and Kapur, *J. Ind. Chem. Soc.*, 1934, 9, 767.

fact that this is another substance which in spite of being diamagnetic like titanium chloride shows negative rotation. In the formula of Ladenberg<sup>3</sup> and others<sup>4</sup> for the Faraday effect there exist two terms, one which covers the case of diamagnetic part of the molecule and the other the paramagnetic part. This anomalous effect may be attributed to the influence exercised by the paramagnetic term of these formulæ. Further work is in progress and the results will be communicated shortly.

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### The Optical Rotatory Dispersion of $\alpha$ - and $\beta$ -Pinenes in the Ultra-Violet.

IN our previous work<sup>5</sup> it was found that the optical rotatory dispersion of  $\alpha$ -pinene till  $\lambda = 3000\text{\AA}$  could be satisfactorily expressed by a single term Drude's equation of the form  $[\alpha] = \frac{k}{\lambda^2 - \lambda_0^2}$  the value of the characteristic frequency  $\lambda_0$  being  $1900\text{\AA}$ . This value is in satisfactory agreement with absorption spectrum measurements of  $\alpha$ -pinene in the vapour state.<sup>6</sup> Our measurements on the rotatory dispersion of  $\beta$ -pinene till  $\lambda = 2784\text{\AA}$ , which will be published shortly, also indicate the absence of any maximum on the positive side of its rotatory dispersion curve. These observations are in contradiction with those reported by Servant<sup>7</sup> according to whom both  $\alpha$ - and  $\beta$ -pinenes in dilute alcoholic solutions attain maximum values in the region  $\lambda = 2800\text{\AA}$ . Our measurements had been made on the pure liquids without the use of any solvent, but since a solvent effect of such magnitude seemed improbable in these cases we measured the rotatory dispersion in alcoholic solutions at approximately the same concentration as was used by Servant. In both cases our previous observations have been confirmed because no anomaly has been noticed till the limit of

<sup>3</sup> Ladenberg, *Zeit. f. Phys.*, 1927, 46, 168.

<sup>4</sup> Rosenfeld, *Zeit. f. Phys.*, 1930, 57, 835.

<sup>5</sup> *J. A. C. S.*, 1935, 57, 334.

<sup>6</sup> Stark, Steubing, Einklaar and Lipp, *Jahrb. Radioactivitat*, 1913, 10, 139.

<sup>7</sup> Servant, *Compt. Rend.*, 1932, 194, 368.