

## INVESTIGATIONS IN THE INFRA-RED

## Part II.

*Absorption Spectrum of Boric Acid.*

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**ABSTRACT.** The infra-red spectrum of boric acid,  $H_3BO_3$  has been investigated between the region  $5\mu$  to  $15\mu$ . As many as eight absorption bands have been observed. Three of them correspond to the vibrational frequencies associated with the  $BO_3$  radical while the others are due to the molecule  $B(OH)_3$ .

## INTRODUCTION.

In a previous communication <sup>1</sup> the molecular structure of inorganic borates as revealed from the study of their near infra-red absorption spectra was discussed. The radical  $BO_3$  was assigned a plane triangular configuration, having three active vibrational frequencies corresponding to the bands at  $7.5\mu$ ,  $11\mu$  and  $14\mu$  and an optically inactive one at  $9\mu$ . The magnitude of the latter was, however, postulated from an analogy with the radicals  $CO_3$  and  $NO_3$ . It was proposed there to ascertain correctly this inactive frequency from a study of the Raman spectra of these salts.

Meanwhile Joglekar and Thatte <sup>2</sup> have investigated the Raman spectra of a few organic and inorganic borates. In addition to the fundamental frequency at  $14\mu$ , they have identified a Raman frequency corresponding to the optically inactive one at  $9\mu$  as assumed above for the  $BO_3$  radical. Very recently the results of the above authors on organic borates have been in main confirmed by Ananthakrishnan <sup>3</sup> who has also studied the Raman spectrum of boric acid. A continuous background rendered it difficult to identify more than one Raman frequency at  $875\text{ cm}^{-1}$  which he attributed to the  $H_3BO_3$  molecule. It was therefore thought desirable to investigate the infra-red spectrum of this molecule where the above difficulty can be avoided and thus obtain more complete data of its vibration frequencies which may lead to an understanding of its constitution.

## EXPERIMENTAL RESULTS.

The experimental arrangement and the region of investigation are same as in previous work. Fig. 1 shows the absorption curve for boric acid. The wave-

lengths of the characteristic bands and the corresponding frequencies are tabulated in table I. For comparison, the Raman frequency data of methyl borate between the region  $5\mu-15\mu$ , as well as the infra-red data of inorganic borates are included.

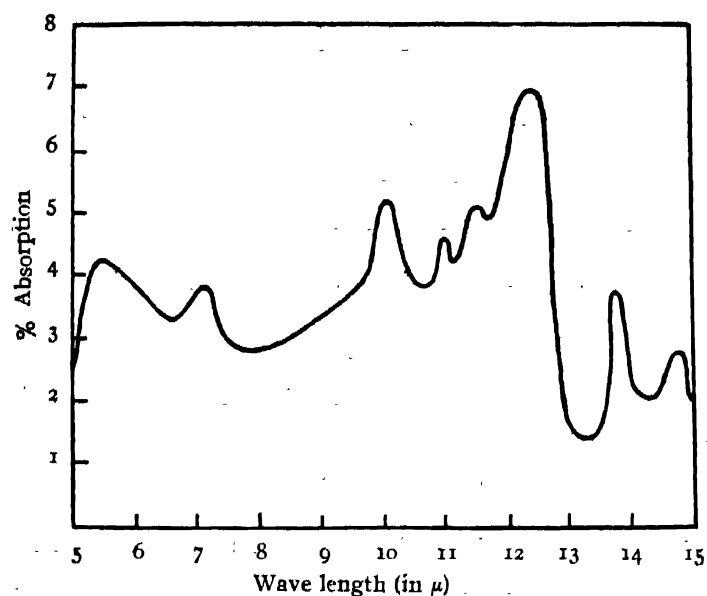


FIGURE I.

TABLE I.

Infra-red data.		Raman Spectra data.		
Boric Acid ( $H_3BO_3$ ).	Inorganic Borates ( $BO_3$ ).	Methyl Borate $(CH_3)_3BO_3$ .	Boric Acid $H_3BO_3$ .	
Author.	Sen and Sen Gupta.	Ananthakrishnan.	Joglekar and Thatte.	Ananthakrishnan.
675 ( $14.8\mu$ )				
724 ( $13.8\mu$ )	715 ( $14.0\mu$ )	728	710	
800 ( $12.5\mu$ )			860	875
869 ( $11.5\mu$ )	909 ( $11.0\mu$ )			
909 ( $11.0\mu$ )		1030	1028	
997 ( $10.1\mu$ )		1117	1112	
		1174		
1389 ( $7.2\mu$ )	1333 ( $7.5\mu$ )	1460	1459	
			1563	
1818 ( $5.5\mu$ )			1753	
			1959	

## INTERPRETATION OF RESULTS.

It is evident that the three active frequencies corresponding to  $7.5 \mu$ ,  $11 \mu$  and  $14 \mu$  which have been previously attributed to the  $\text{BO}_3$  radical from a study of the infra-red absorption spectra of the inorganic borates are also present in the spectrum of boric acid. Similar relationship has been noticed between dilute nitric acid and inorganic nitrates. Dadiou and Kohlrausch <sup>4</sup> observed that although the Raman spectra of conc.  $\text{HNO}_3$  and organic nitrate  $\text{CH}_3\text{ONO}_2$  are very similar, the spectrum of the diluted acid resembles that of its inorganic salts. This behaviour has been attributed to the dissociation of  $\text{HNO}_3$  into  $\text{H}$  and  $\text{NO}_3$  ions on dilution. Recently Aderhold and Weiss <sup>5</sup> also have come to the same conclusion. In the case of sulphuric acid Woodward <sup>6</sup> and others <sup>7</sup> are of opinion from the study of its Raman spectrum that with dilution the molecule first dissociates into  $\text{HSO}_4'$  and then into  $\text{SO}_4''$  ions.

The frequencies  $675$ ,  $869$  and  $990 \text{ cm}^{-1}$  may be attributed to the molecule,  $\text{H}_3\text{BO}_3$ . Of these, the one at  $869 \text{ cm}^{-1}$  is evidently identical with the Raman frequency,  $875 \text{ cm}^{-1}$ , reported by Ananthakrishnan and assigned to the totally symmetrical vibration of the molecule  $\text{B}(\text{OH})_3$ . The justification of attributing the two frequencies,  $675$  and  $990 \text{ cm}^{-1}$ , to  $\text{H}_3\text{BO}_3$ , is derived from a comparison of their magnitudes with those of the Raman frequencies observed in the spectra of  $\text{H}_3\text{PO}_3$  by Ghosh and Das.<sup>8</sup> For the latter molecule, these authors have reported three frequencies at  $672$ ,  $940$  and  $1012 \text{ cm}^{-1}$ . The first two seem likely to correspond to the frequencies  $675$  and  $990 \text{ cm}^{-1}$  observed in the infra-red spectrum of boric acid. It may, however, be mentioned that corresponding to the frequency at  $1012 \text{ cm}^{-1}$ , a Raman frequency of magnitude nearly  $1028 \text{ cm}^{-1}$  has been observed in the spectrum of methyl borate. This does not appear in the infra-red spectrum of boric acid and is probably an optically inactive frequency.

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