ON THE ANOMALOUS DISPERSION AND ABSORPTION OF ELECTRIC WAVES. III.

By San-ichiro MIZUSHIMA.

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With the electric wave of 9.5 metres, the measurements were carried out as the continuation of previous experiments.(1) The results obtained for monovalent alcohols are shown in the following tables.

ΔC : Displacement of glass plate,

$\Delta C'$: Corrected value of ΔC,

I/I_0 : Ratio of the deflections of the galvanometer at resonance,

ε : Dielectric constants,

K : Electric conductivity which is equivalent to anomalous absorption (cm^{-1} ohm^{-1}).

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TABLE 1. Methyl alcohol.

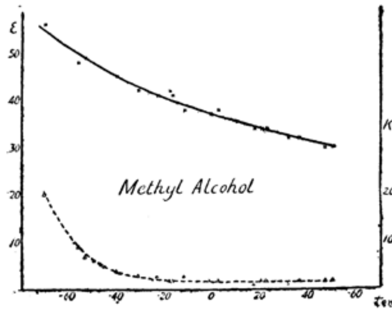
Vessel.	Temp.	ΔC	I/I_0	$\Delta C'$	ε	$K \times 10^5$	ε (Other authors)
II	50	4.35	.58	4.35	30	2	
II	47	4.4	.58	4.4	30	2	
IV	46	5.7	.56	5.7	30	2	
II	36	4.7	.58	4.7	32	2	
III	31	5.4	.57	5.4	32	1	
IV	31	6.25	.59	6.25	32	1	
II	22	5.1	.58	5.1	34	2	
III	20	5.85	.56	5.85	34	2	
IV	17	6.8	.60	6.8	34	1	
—	13.4	—	—	—	—	—	35.3 (L.)
II	2	5.85	.56	5.85	38	2	
—	0	—	—	—	—	—	35.0 (A.S.)
I	−1	4.65	.58	4.65	37	2	
I	−12	4.85	.53	4.85	38	3	
II	−17	6.4	.50	6.4	41	2	
II	−18	6.6	.50	6.6	42	2	
I	−23	5.25	.51	5.25	41	3	
I	−31	5.5	.48	5.5	42	3	
I	−40	5.9	.40	5.9	45	4	
—	−50	—	—	—	—	—	45.3 (A.S.)
I	−53	6.55	.28	6.55	49	7	
I	−56	6.55	.24	6.55	48	9	
II	−70	9.6	.08	9.25	56	20	

TABLE 2. Ethyl alcohol.

Vessel.	Temp.	$\Delta C'$	I/I_0	$\Delta C'$	ε	$K \times 10^5$	ε (Other authors)
I	54	2.35	.80	2.35	20.5	—	
II	53	2.9	.75	2.9	20	—	
—	50	—	—	—	—	—	20.5 (W.)

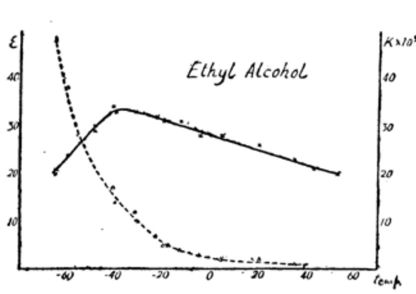
TABLE 2. *Continued.*

Vessel.	Temp.	ΔC	I/I_0	$\Delta C'$	ε	$K\times10^5$	ε (Other authors)
II	43	3.1	.70	3.1	21	1	
I	35	2.7	.74	2.7	23	1	
II	20	3.85	.56	3.85	26	2	25.8 (A.S.)
I	17	3.05	.67	3.05	25	2	
—	14.7	—	—	—	—	—	26.8 (T.)
I	4	3.4	.58	3.4	28	2	
—	0	—	—	—	—	—	28.4 (A.S.)
I	− 5	3.5	.54	3.5	28	3	
I	−13	3.85	.46	3.85	31	4	
I	−18	4.0	.36	4.0	31	5	
I	−20	3.9	.35	3.9	31	5	
I	−23	4.05	.30	4.05	32	7	
I	−32	4.35	.18	4.3	33	12	
I	−40	4.4	.16	4.3	33	14	35.3 (A.S.)
I	−41	4.55	.14	4.45	34	17	
II	−49	5.25	.05	4.6	29	29	
I	−49	4.4	.07	3.9	30	29	
I	−60	3.85	.05	3.15	24	38	
I	−65	3.6	.04	2.75	21	48	
II	−65	4.55	.03	3.15	20	48	



×.........Value of ε
△.........Value of K

Fig. 1.



×.........Value of ε
△.........Value of K

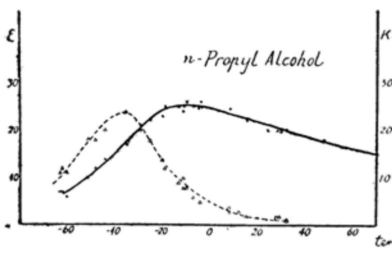
Fig. 2.

TABLE 3. Propyl alcohol.

Vessel.	Temp.	ΔC	I/I_0	$\Delta C'$	ε	$K \times 10^5$	ε (Other authors)
I	70	1.7	—	1.7	15	—	
IV	48	3.35	.76	3.35	18	<1	
IV	32	3.85	.64	3.85	20	1	
IV	29	3.85	.50	3.85	20	2	
I	29	2.3	.60	2.3	20	2	
I	28	2.35	.61	2.35	20	2	
I	24	2.35	.69	2.35	20	1	
—	20	—	—	—	—	—	22.2 (A.S.)
IV	15	4.35	.43	4.35	22	2	
—	14.3	—	—	—	—	—	22.4 (L.
IV	8	4.9	.33	4.9	24.5	3	
IV	8	4.9	.30	4.9	24.5	4	
—	0	—	—	—	—	—	24.8 (A.S.)
IV	− 4	5.3	.24	5.3	26	5	
III	− 7	4.3	.22	4.3	25	6	
IV	−10	5.35	.16	5.25	26	8	
III	−11	4.45	.18	4.4	25	8	
IV	−11	5.05	.13	4.9	24	10	
IV	−13	5.35	.14	5.2	25	9	
III	−19	4.7	.12	4.5	25	12	
I	−20	3.05	.16	2.95	23	14	
IV	−25	5.0	.07	4.5	22	18	
III	−29	4.15	.07	3.65	21	20	
I	−35	2.55	.09	2.1	17	24	
III	−44	3.0	.07	2.5	14	20	
III	−48	2.45	.08	2.05	12	18	
IV	−51	2.45	.07	1.95	10	18	
III	−60	1.1	.14	0.95	6	11	33.7 (A.S.)
	−62	0.9	.18	0.85	7	12	
IV	−63	1.5	.12	1.3	7	11	

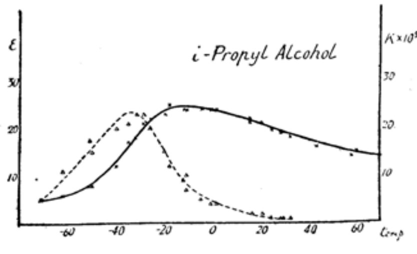
TABLE 4. Isopropyl alcohol.

Vessel.	Temp.	ΔC	I/I_0	$\Delta C'$	ε	I/I_0
III	70	2.2	—	2.2	14	<1
III	60	2.4	.83	2.4	15	<1
II	59	2.0	.86	2.0	14	<1
III	43	2.6	.78	2.6	16	<1
III	32	3.0	.68	3.0	18	1
II	31	2.65	.76	2.65	18.5	<1
III	29	3.1	.65	3.1	19	1
II	29	2.7	.67	2.7	19	1
III	28	3.15	.67	3.15	19	1
III	24	3.25	.59	3.25	19.5	1
IV	20	4.1	.48	4.1	21	2
III	15	3.65	.50	3.65	22	2
II	15	3.15	.47	3.15	21	2
III	1	4.05	.33	4.05	24	4
IV	−1	4.9	.28	4.9	24	4
III	−5	4.15	.24	4.15	24	5
III	−11	4.25	.20	4.25	24	7
II	−11	3.75	.17	3.65	24	10
IV	−12	5.05	.15	4.95	24	9
III	−18	4.65	.12	4.45	25	12
III	−20	4.4	.10	4.1	23	15
II	−26	3.75	.08	3.4	22	20
III	−29	4.25	.06	3.65	21	23
III	−32	3.75	.06	3.15	18	23
III	−35	3.65	.05	2.95	17	26
IV	−40	2.9	.06	2.25	12	20
III	−50	1.65	.10	1.35	8	15
II	−51	1.5	.10	1.2	8	17
III	−62	1.1	.13	0.9	6	11
II	−71	0.7	.30	0.7	5	5



× .... Value of ε
△ .... Value of K

Fig. 3.



× .... Value of ε
△ .... Value of K

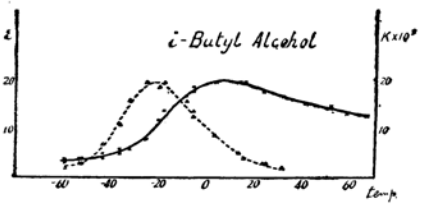
Fig. 4.

TABLE 5. Isobutyl alcohol.

Vessel.	Temp.	ΔC	I/I_0	$\Delta C'$	ε	$K\times10^5$	ε (Other authors)
IV	66	2.4	.90	2.4	13	<1	
III	58	2.15	.81	2.15	13.5	<1	
IV	51	2.8	.84	2.8	15	<1	
III	40	2.55	.70	2.55	15.5	<1	
IV	31	3.3	.58	3.3	17	2	
IV	24	3.5	.40	3.5	18	3	
III	23	3.05	.40	3.05	18	3	
III	22	3.0	.40	3.0	18	3	
—	18	—	—	—	—	—	18.9 (T.)
III	15	3.8	.27	3.8	20	4	18.7 (L.)
IV	14	3.3	.34	3.3	20	4	
III	14	3.35	.29	3.35	20	4	
III	13	3.45	.26	3.45	20	5	
IV	12	4.0	.25	4.0	20	4	
IV	3	4.1	.15	4.0	20	9	
—	0	—	—	—	—	—	21.8 (A.S.)
III	− 6	3.45	.11	3.2	19	14	
IV	− 6	3.85	.11	3.6	18	13	
IV	− 9	3.8	.08	3.4	17	16	
III	−18	2.85	.07	2.35	14	20	
III	−20	2.4	.07	1.95	12	19	
IV	−25	2.1	.06	1.45	8	20	
III	−32	1.25	.09	0.9	6	16	
III	−36	1.0	.13	0.85	6	11	
IV	−36	1.1	.12	0.9	5	11	
—	−40	—	—	—	—	—	27.0 (A.S.)
III	−43	0.75	.20	0.7	5	7	
IV	−43	0.8	.18	0.7	4	7	
III	−52	0.55	.34	0.55	4	3	
IV	−53	0.6	.37	0.6	4	3	
III	−59	0.5	.48	0.5	4	2	
IV	−59	0.55	.44	0.55	3	2	

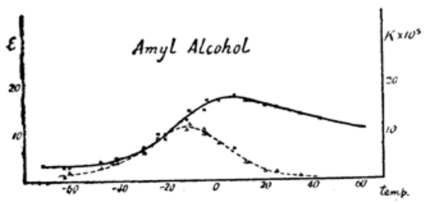
TABLE 6. Amyl alcohol.

Vessel.	Temp.	ΔC	I/I_0	$\Delta C'$	ε	$K\times10^5$	ε (Other authors)
IV	61	2.05	.88	2.05	11	<1	
III	60	1.7	.81	1.7	11	<1	
III	43	2.05	.72	2.05	13	<1	
IV	35	2.7	.63	2.7	14	1	
IV	25	2.95	.48	2.95	15.5	2	
II	20	2.3	.46	2.3	16	2	16.0 (A.S.)
—	13.8	—	—	—	—	—	16.6 (L.)
III	13	2.8	.30	2.8	17	4	
II	12	2.5	.34	2.5	17	4	
I	7.5	2.15	.30	2.15	18	7	
IV	1	3.25	.16	3.25	17	8	
—	0	—	—	—	—	—	17.4 (A.S.)
I	− 4	2.05	.22	2.05	17	10	
IV	− 5	3.2	.12	3.0	15	11	
III	− 5	2.75	.15	2.6	15	10	
II	−11	2.35	.14	2.2	15	12	
III	−12	2.35	.13	2.15	13	11	
IV	−12	2.65	.11	2.45	13	11	
III	−21	1.7	.15	1.55	9	10	
IV	−21	1.85	.13	1.7	9	10	
I	−24	1.2	.23	1.2	10	9	
II	−30	0.95	.24	0.95	7	7	
IV	−30	1.1	.20	1.1	6	6	
I	−41	0.5	.42	0.5	5	4	
I	−43	0.4	.45	0.4	4	4	
II	−48	0.45	.44	0.45	4	3	
—	−50	—	—	—	—	—	23.0 (A.S.)
II	−61	0.3	.60	0.3	3	2	
I	−63	0.2	.74	0.2	3	1	



×.........Value of ε
△......... Value of K

Fig. 5.



×.........Value of ε
△.........Value of K

Fig. 6.

Table 7 contains the values of ε and K at every tenth degree of temperature obtained by graphical interpolation from the above results.

TABLE 7.

Temp.	Acetone	Glycerine		Methyl alcohol		Ethyl alcohol		Propyl alcohol		Isopropyl alcohol		Isobutyl alcohol		Amyl alcohol	
	ε	ε	$K \times 10^5$	ε	$K \times 10^5$	ε	$K \times 10^5$	ε	$K \times 10^5$	ε	$K \times 10^5$	ε	$K \times 10^5$	ε	$K \times 10^5$
70	—	35	<1	—	—	—	—	15	<1	14	<1	—	—	—	—
60	—	37	1	—	—	—	—	16	<1	15	<1	14	<1	11	<1
50	—	39	2	30	2	21	<1	17	<1	16	<1	15	<1	12	<1
40	—	40	4	31	2	22	1	19	<1	17	<1	16	<1	13	1
30	—	42	8	33	2	23	1	20	1	19	1	17	2	15	1
20	22	41	15	34	2	25	1	22	2	21	1	19	3	16	2
10	23	34	25	35	2	27	2	23	3	22	3	20	6	18	5
0	24	20	26	37	2	28	2	25	5	24	5	20	10	17	9
−10	25	12	12	39	2	30	4	25	8	25	8	17	15	15	11
−20	26	8	4	40	2	31	6	24	14	24	15	11	20	10	10
−30	27	5	2	42	3	33	10	20	22	19	23	7	17	7	7
−40	28	4	1	45	4	33	15	15	23	13	22	5	9	5	4
−50	29	4	<1	48	7	29	23	10	18	8	16	4	4	4	3
−60	30	4	<1	51	12	24	36	7	12	6	10	4	2	4	2
−70	31	4	<1	55	20	—	—	—	—	5	5	—	—	3	1

The behaviours of propyl, isopropyl, isobutyl, and amyl alcohols are, in general, quite similar to that of glycerine. At higher temperatures there is only little absorption and the values of ε obtained are found to be in good agreement with those measured at longer waves. As the temperature is gradually lowered, both ε and K increase, till each of them reaches its maximum respectively. The maximum of K lies at the point where the temperature coefficient of ε is nearly maximum. (See figures). At still lower temperatures, the values of K are decreasing and those of ε approaching to the square of the refractive indices for the visible light.

For ethyl alcohol, only the maximum of ε is obtained, and for methyl both of the maxima are not found. But it may be granted that at sufficiently low temperatures they will also behave as other alcohols.

As given above these alcohols show anomalous absorptions of the electric wave of the wave length of 9.5 metres as well as 6.1 metres, and these absorptions are incomparably greater than those expected from their electric conductivities. Anomalous changes of dielectric constants are observed at the same time. The point of maximum absorption lies always at the temperature at which the temperature coefficient of the anomalous change of ε is nearly maximum. The value of ε at this point is nearly equal to the mean of the dielectric constant at long wave lengths and the square of the refractive index for the visible light. From this fact it can evidently be expected that if the change of ε by the wave length be studied at constant temperature, the point of the maximum change of ε (i. e. the point where the dispersion is most anomalous) will be accompanied by a very strong absorption of the wave. Experiments are now continued with waves of different wave lengths in order to obtain the data necessary for the study of the above relation and its analogy to that between the anomalous dispersion and absorption of the visible light.

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Laboratory of Physical Chemistry,
Faculty of Science, Tokyo Imperial University.