period the *a-v*-interval is again much shortened, in the then following period it lengthens again.

We found thus, that heart-bigeminy after poisoning with veratrine can develop itself in 3 ways.

1. as transition-stage between the normal rhythm and the halved one;

2. by alternating retardation in the conduct-systems between the different heart-partitions.

3. with accumulations of extra-systoles after blockading of the connection-systems between sinus venosus and atrium. I found the manner of development as it is indicated by HERING only in disconnected groups. I never found a row of bigeminus-groups of which every 2nd systole was an extra-systole.

Geophysics. — *On the relation between departures from the normal in the strength of the trade-winds of the Atlantic Ocean and those in the waterlevel and temperature in the northern European seas.* By P. H. GALLÉ. (Communicated by Dr. J. P. VAN DER STOK).

(Communicated in the meeting of February 27, 1915).

1. From hydrodynamical and oceanographical investigations in the North-Sea, the Baltic, the Norwegian and the Barents-Sea, the existence of the following phenomena is evident.

a. Mean values from Dutch [1]), Norwegian [2]), German [3]) and Finnish [4]) tide-gauges show an annual periodicity in the waterlevel of the North-Sea and the Baltic, displaying a minimum in spring, a maximum and secondary-maximum — separated by a rather clearly indicated secondary-minimum — in autumn.

b. Temperature and salinity observations of the underlayers in the North-Sea [3]), the Norwegian [5]) and the Barents-Sea [6]), show a periodicity

1) Koninklijk Nederlandsch Meteorologisch Instituut N⁰. 90.
J. P. VAN DER STOK. Etudes des phénomènes de marée sur les côtes néerlandaises.
I. Analyse des mouvements périodiques et apériodiques du niveau de la mer, 1904.

2) H. GEELMUYDEN. Resultater af Vandstands Observationer paa den Norske Kyst. Hefte VI, 1904.

3) OTTO PETTERSSON. Ueber die Wahrscheinlichkeit von periodischen und unperiodischen Schwankungen in dem Atlantischen Strome und ihren Beziehungen zu meteorologischen und biologischen Phaenomenen. Rapports et Procès Verbaux du Conseil Permanent pour l'Exploration de la mer. Vol. III, 1905.

4) ROLF WITTING. Finländische Hydrographische-Biologische Untersuchungen N⁰. 7, Helsingfors 1912.

5) Report on Norwegian Fishery and Marine-Investigations Vol. II, 1909, N⁰. 2. The Norwegian Sea, its physical oceanography, based upon the Norwegian Researches 1900—1904 by BJÖRN HELLAND—HANSEN and FRIDTJOF NANSEN.

6) L. BREITFUSZ. Oceanographische Studiën über das Barentsmeer. Petermanns Geogr. Mitth. 1904 Heft II.

of the same kind; a minimum in spring, a corresponding maximum in autumn.

To explain the phenomenon, whose generality has become known only of late years, different ways have been tried.

In the supposition that it was limited to the southern part of the North-Sea and the Baltic and thinking the wind responsible for the periodical fluctuations VAN DER STOK comes to the following conclusion.[1])

"A comparison of these (wind) results with those, indicating the periodical and non-periodical fluctuation of the sealevel shows, that — though some correspondency as the distinct November-minima cannot be denied — a real connection fails. Neither the April-minimum, nor the October-maximum can be explained as a result of the wind on our coast.

A more accurate investigation of the fluctuations in the waterlevel as well as of those in the windsystem both on the Dutch coast and the whole North-Sea is desirable."

GEELMUYDEN says:

"The yearly fluctuation is very marked along the whole Norwegian coast; I think an explanation must be looked for in periodical changes of pressure and wind."

In PETTERSON's work the following quotation is to be found:

"If on the other hand, only Dutch observations had been accessible, the inferences drawn from them would certainly have pointed to the wind as the originator of the fluctuations. Now, since a comparison of facts has shown the analogy of the fluctuations in the North-sea, the Baltic and the Kattegat, such inferior explanations are excluded, and we must acknowledge the fluctuations to be the outcome of a general pulsation of the ocean from the tropics to the Polar Sea. The pulsation of the northern seas is analogous with that of the Atlantic."

Speaking about the North-Atlantic Current it is evident he considers that stream not to be a direct offshoot of the Gulfstream, an opinion not generally shared.

WITTING after having pointed out the correspondency of phenomena in North-Sea and Baltic, tries to find an explanation in fluctuations in the quantity of water in these seas. In his opinion these fluctuations are caused by the wind, however not by the wind in the North-Sea or in the Baltic, but so far as the Baltic is concerned by the wind near its gates; the Skager Rak, the Belts and the Kattegat.

BREITFUSZ found from serial-observations in latitude 71° N. and

[1]) l. c. p. 20.

longitude 33°.5 E. that from June till November the temperature as well as the salinity of the whole watermass increased and especially in the deeper layers. The velocity of the current also increased in this period; we have to do here with the Northcape-current, one of the outer ramifications of the Gulfstream. After discussing this increase BREITFUSZ continues·

"Not in local conditions we should look for the origin of these fluctuations, but in the Gulfstream and in the many causes that modify the stream on its way, thousands of miles long, from its cradle under the Equator, through the Caribbean Sea and the Atlantic to the Polar regions.

2. In our opinion fluctuations in the intensity of the Gulfstream are the cause of the fluctuations in the waterlevel and we were strengthened in this opinion, when we learned from BREITFUSZ's investigations the general nature of this phenomenon.

But if fluctuations in the Gulfstream are responsible, then it must be possible to detect a similar periodicity in the North- and South-Equatorial current and in the North- and South-East trades.

We calculated the monthly mean values and departures from

TABLE I.

	Number of days with obser-vations	Current 1855—1900			Wind 1855—1914		
		Direction	Miles in 24 h.	Departure	Direction	Meters p. sec.	Departure
January	1393	N 281° E.	4.95	—1.27	N 64° E.	5.46	+0.26
February	1161	285	4.41	—1.81	62	5.17	—0.03
March	1398	282	5.05	—1.17	63	4.65	—0.55
April	1138	282	5.34	—0.88	62	4 69	—0.51
May	1425	285	5.89	—0.33	60	5.76	+0.56
June	1250	278	6.97	+0.75	59	6.25	+1.05
July	1411	272	8.90	+2.68	56	6.12	+0.92
August	1265	267	7.50	+1.28	56	5.28	+0.08
September	1114	268	7.84	+1.62	61	5.28	+0.08
October	1098	270	6.71	+0.49	67	4.54	—0.66
November	1096	269	6.17	—0.05	64	4.55	—0.65
December	1411	273	4.90	—1.32	68	4.71	—0.49

yearly mean values for the region 15°—25° N. and 25°—40° W., as given in the preceding table [1]).

For the South-Atlantic monthly data are not at our disposition, below we give the three-monthly mean values and departures from the normal for the region 5°—10° S. and 15°—35° W. [2]).

TABLE II.

	Direction	m. p. sec.	Departure
Dec.—Febr.	N 123° E.	4.58	— 0 56
March—May	117	4.29	— 0.85
June—Aug.	132	6 12	+ 0.98
Sept.—Nov.	137	5.58	+ 0.44

Maxima and minima of the North-East and South-East trades appear to coincide fairly well, table I shows a real correspondency between the North-East trade and the North-Equatorial current; the positive and negative departures in the strength of the trade wind correspond with one exception, with those in the velocity of the Equatorial current and show a difference in phase of one month. We should keep in mind, that winds with great stability as the trades and monsoons are generally considered to be the prime current-generators: furtheron in this study we will try to explain departures from normal-level in the North-Sea or from the normal-surface of open water in the Barents-Sea, with the aid of fluctuations in the strength of the North-East trade.

It would be better for this purpose to make use of fluctuations in the North-Equatorial current, but as a matter of fact current-observations are always less in number than windobservations and therefore we have to rely on the wind.

In the following table we give the monthly departures from the yearly mean level, as they have been calculated from long tide-gauge-observations at 7 Baltic and 3 North-Sea stations; Fig. 1 shows the departures in velocity of the stream and in the waterlevel.

1) Kon. Ned. Met. Instituut

N°. 95. Observations océanographiques et météorologiques dans la region du courant de Guinée 1855—1900. Utrecht 1904.

N°. 107. Monthly Meteorological Data for ten-degree squares in the Atlantic and Indian Oceans 1900—1914.

2) Pilot Chart of the South Atlantic Ocean. Dec.—Jan.—Febr. etc. Hydrographic Office and Weather Bureau Washington D. C.

The correspondency is considerable, in spring we have a phase-difference of two months, in autumn of three, it stands to reason that either phasedifference can be $2^1/_2$ months.

TABLE III.

Monthly departures in waterlevel in cm.											
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
−2.5	−4.0	−5.8	−9.0	−6.7	−3.1	+3.4	+5 7	+6.7	+8.6	+1.7	+5.6

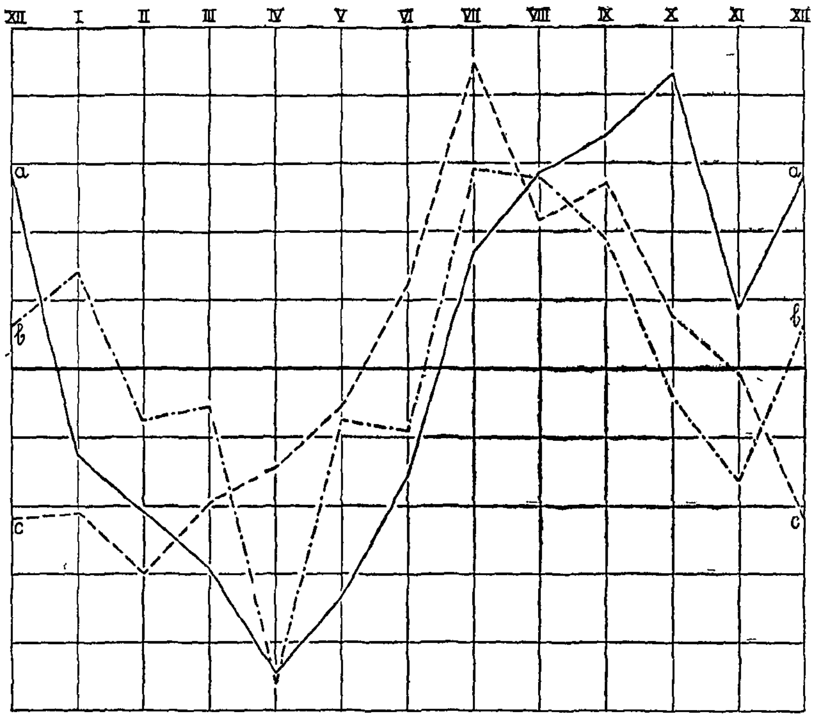

Fig. 1.

a. Waterlevel North-Sea and Baltic. *b.* Raising-power North-Sea-wind. *c.* Equatorial Current.

It is evident from the above:

1st. Monthly fluctuations in the velocity of the North-Equatorial current (or in the strength of the North-East trade) are responsible for monthly fluctuations of the waterlevel in the North-Sea and the Baltic.

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2nd. The two groups of fluctuations show a phasedifference of 2 or 3 months.

3rd. The origin of the Gulfstream lies under the Equator, the North-Atlantic current is a direct offshoot of the Gulfstream and is the connection between the Gulfstream proper and the North-Sea, the Baltic, the Norwegian and the Barents-Sea.

4th. BREITFUSZ was in 1904 the first to point out the direction in which we had to look for the solution of this problem.

3. We mentioned before that VAN DER STOK and WITTING thought the water-raising power of the local wind or of that near the entrances of the North-Sea and the Baltic responsible for the fluctuations in the waterlevel.

We do not know how WITTING proceeded; from mean monthly windresultants, as calculated but not published by VAN DER STOK for Swambister, Bergen, Skudeness, Helder and Flushing, we derived a mean monthly "North-Sea-wind" (Table IV).

TABLE IV.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Direction	206°	207	220	278	314	321	282	256	235	216	196	199
M. p. s.	2.69	2.15	1.88	0.58	1.80	1.90	2.05	2.03	2.06	1.99	2.42	2.86

The first thing necessary to cause a rise of the waterlevel on a coast is a motion of the water or a current perpendicular to that coast. The direction of the Dutch, Danish, and Norwegian coast is about SSW—NNE; a maximum rise of the water will be caused by an ESE-ly current. WITTING has shown that between wind and winddrift in inland seas as the Baltic, a difference in direction exists of 25° to the right (southern latitude to the left); the most favourable winddirection to cause a rise of the water, is in our case N 268°0 E.

In order to judge of the waterraising-power of the different monthly windresultants of table IV we project them on the direction N 268° E. and consider the squares of the projections; we get the following monthly values and departures from the mean (Table V *b* Fig. 1).

The minima in spring and autumn in waterlevel and raising-power coincide; the maximum raising-power between July and August is

TABLE V.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
3.34	2.24	2.36	0.33	2.25	2.17	4.07	4.03	3.56	2.43	1.81	2.93
+0.72	—0.38	—0.26	—2.29	—0.37	- 0.45	+1.45	+1.41	+0.94	—0.19	—0.81	+0.31

followed by a maximum in level in October, the December-level-maximum nearly coincides with the maximum in raising-power of the wind between December and January.

We also calculated the raising-power of the monthly windresultants and their departures from the normal (*b*) alone for the Dutch coast (Table VI); Fig. 2 shows them with the departures in waterlevel (*a*) on the Dutch coast and those in the Equatorial current (*c*).

TABLE VI.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
a—1.4 cM.	—7.0	—5.8	—9.7	—6.1	—4.2	+1.3	+4.6	+6.0	+12.1	+2.6	+7.7
b—0.31	—0.42	+0.11	—2.87	—3.60	—0.43	+1.87	+3.66	+1.89	+0.21	—1.86	+0.82

The correspondency between the different curves has become clearer and we cannot doubt any longer that besides fluctuations in the velocity of the Equatorial current, monthly fluctuations in the waterraising-power of the wind are responsible for periodical fluctuations in the waterlevel of the North-Sea and adjoining seas.

The question is raised:

"Is it possible to express numerically the relation between fluctuations in waterlevel in the North-Sea and in the Baltic and fluctuations in the trade-winds and waterraising-power of the wind on our coast?"

We have already pointed to the fact that for the solution of this question we had to consider the Equatorial current or trade-wind for an earlier period as that relative to the waterlevel.

In our opinion the waterlevel of 1914 is governed by the Equatorial current November 1913—October 1914. The correlationfactor between fluctuations in waterlevel and trade-wind is 0.66.

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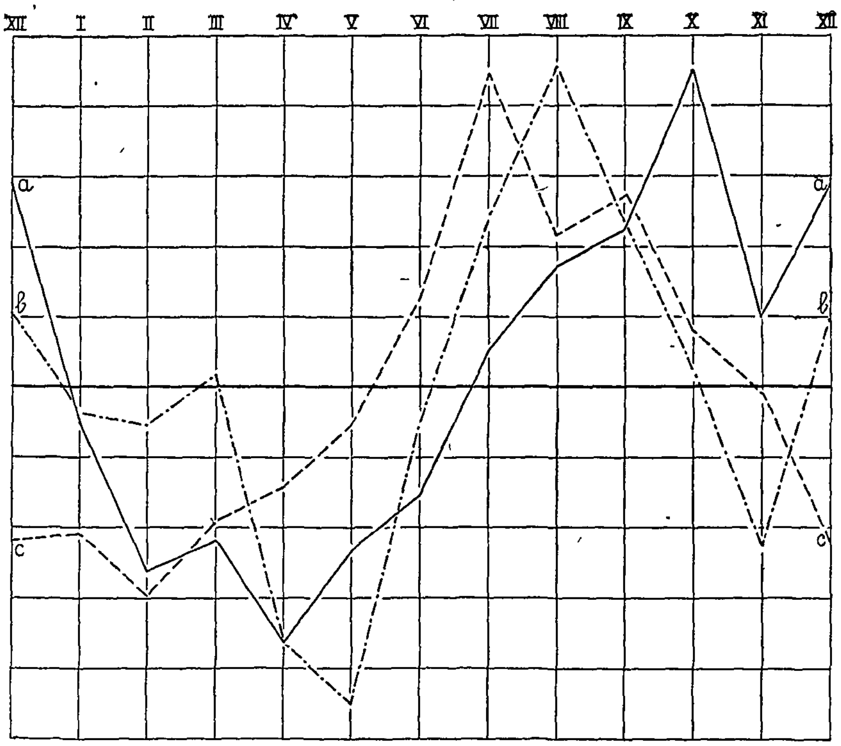

Fig. 2.

a. Waterlevel Dutch coast. *b*. Raising-power wind Dutch coast.
c. Equatorial Current.

The correlation between waterlevel, trade-wind and water-raising power is 0.82.

If it were possible to make a trustworthy prognostication about the "North-Sea wind", we should be able to forecast with a fair certainty the level to be expected, for during two years we have known fairly well the behaviour of the trade winds from month to month, [1]) a progress made by international coöperation on VAN DER STOK's instigation.

The correlation between fluctuations in the Equatorial current and the waterlevel is far greater viz. 0.85. It will be tried to secure current observations in time in sufficient quantity, for in our opinion

[1]) Kon. Ned. Meteor. Instituut 107A and 107. Monthly Meteorological Data for ten-degree squares in the Atlantic and Indian Oceans.

107A Computed by the Royal Netherlands Meteorological Institute from Swedish and Dutch Observations 1900—1912 and from international observations January—June 1913.

107 Computed by the Royal Netherlands Meteorological Institute from international logs and observations I[1] January—June 1913, I[2] July—December 1913. Utrecht 1914.

the solution of some meteorological and biological problems is closely connected with a more accurate knowledge of the watertransport through the ocean to our shores.

Geelmuyden found that along the Norwegian coast the behaviour of the waterlevel was the same as along the more southern shores in question; from the constants he gave for the partial tide Sa, it was however not possible to conclude anything about the existence of a November-secondary-minimum.

In the North of Norway the maximum falls later than in the South; the reason why. may perhaps be found, by comparison of table VI with the following table, where we calculated the departures from the average (1893—1913) of the water-raising power of the wind for Bödö.

TABLE VII.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
+0.24	—1.99	—2.56	—0.30	+1.41	+2.17	+2.57	+1.59	+1.88	+0.57	+0.47	+6.11

4. In the preceding pages we think we have. demonstrated that — at least for a rather great number of years — monthly fluctuations in the waterlevel in the North-Sea and the Baltic and halfyearly fluctuations in temperature and salinity in the Barents-Sea are originated by monthly fluctuations in the velocity of the Equatorial current or strength of the North-East trade in the North-Atlantic in connection with the water-raising power of the wind in the neighbourhood.

The question arises — and with this we come to the direct application of the preceding theory — is it possible now, to say something definite about future fluctuations in meteorological or oceanographical elements in one of the Northern Seas.

We told already, why we had — by way of introduction at least — to make use of fluctuations in the North-East trade and that the effect of these fluctuations was felt after about two or three months in the northern European Seas.

We give the following examples.

Pettersson has found that between Thorshavn and Iceland from August 1902—August 1903 the water of Atlantic origin lost 131 Kilogram-calories daily, from August 1903—August 1904 the daily gain was 230 calories.

We have to calculate the mean strength of the trade from June 1902—1903 and 1903—1904 and find N 78° E. 2.07 and N 69° E.

3.26 BEAUFORT-units; the average annual strength is N 70° E. 2.85. These values agree with the above-mentioned figures of loss and gain of heat.

A second series of data to justify our theory we find in HELLAND-HANSEN's and NANSEN's wellknown work [1]), where the following figures for the open water in the Barents-Sea for May are given in thousands of square kilometers.

TABLE VIII.

May	1900	1901	1902	1903	1904	1905	1906	1907	1908
Thousands of □ kilometers	440	398	249	469	696	639	576	645	568

In NANSEN's opinion, the surface of open water depends in a great measure upon the watertemperature of the preceding winter. According to this we have only to compare the strength of the trade with these figures, keeping in mind that departures from the mean surface of open water in May 1900 should be in accordance with departures from the mean strength of the trade-wind for the period Sept. or Oct. 1898—Sept. or Oct. 1899.

In table IX we give the corresponding departures, the correlation is 0.55.

TABEL IX.

1900	1901	1902	1903	1904	1905	1906	1907	1908
—0.28	- 0.43	—0.12	—0.13	—0.10	+0.53	+0.22	+0.03	+0.28
—80	—122	- 271	—51	+176	+119	+56	+125	+48

Lastly we will consider the relation between the departures from the mean value of the annual North-sea level on the Dutch coast [2]) and those in the mean average strength of the trade, in such a way that the windyear ends consecutively 31st August, 30th September etc.; the wateryear always on 31st December. In table X it is evident that a difference in time of two months gives the best

[1]) The Norwegian Sea. Its physical oceanography based upon the Norwegian researches 1900—1904 by BJÖR : HELLAND HANSEN and FRIDTJOF NANSEN. Report on Norwegian Fishery and Marine Investigations. Vol. II 1909. No. 2.

[2]) The data required for this purpose we owe to the service of the "Rijks-Waterstaat".

correlation; in Fig. 3 the curves representing the departures in water level (*b*) and strength of the trade (*a*) are given.

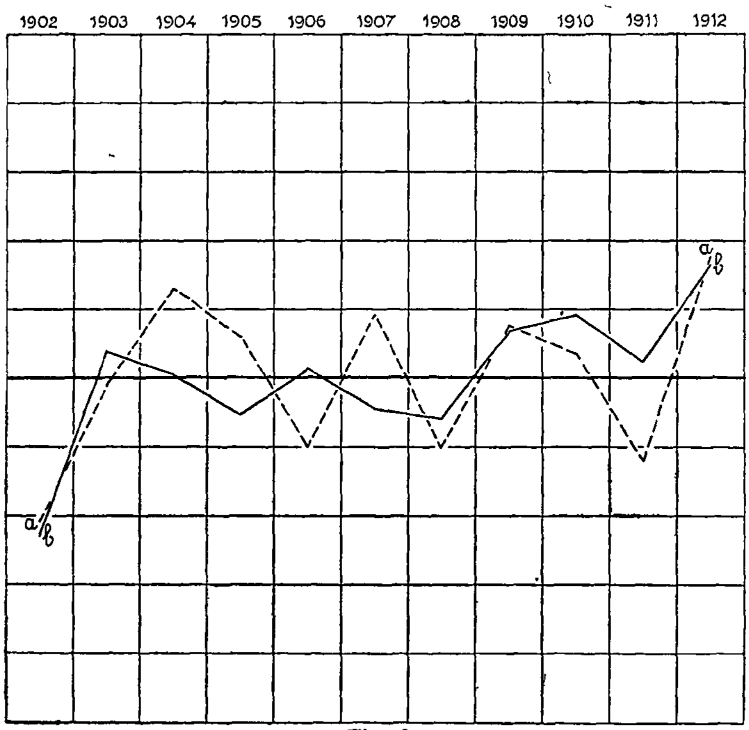

Fig. 3.

TABLE X.

1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912		Corr.
—92 mM.	+15	+1	—23	+4	—18	—23	+27	+37	+9	+65		
—0.18	—0.34	+0.40	+0.08	—0.12	+0.14	- 0.03	+0.04	+0.10	—0.27	+0.17	Aug.	0.24
—0.38	—0.16	+0.35	+0.05	—0.12	+0.13	—0.07	+0.07	+0.11	- 0.30	+0.25	Sept.	0.55
—0.42	—0.02	+0.26	+0.12	—0 20	+0.19	—0.20	+0.14	+0.08	—0.24	+0.34	Oct.	0.65
—0.45	—0.16	+0.28	+0.22	—0.25	+0.38	—0.46	+0.28	—0.07	+0.02	+0.21	Nov.	0.46
—0.42	—0.04	+0.19	+0.18	—0.18	+0.32	—0.46	—0.02	+0.17	—0.08	+0.34	Dec.	0.59

The answer to the question put in the beginning of this chapter, is therefore, that when we have to do with somewhat important departures from the average in the strength of the North-East trade, it seems possible to us, to make a forecast about the sign of the departure from the normal of some phenomena in the Northern European seas.

Whether the correlation will prove to be greater or smaller if longer series are at our disposition, cannot be said with any certainty beforehand.

Chemistry. — "*The connexion between the limit value and the concentration of Arsenic Trisulphide sols*". By Dr. H. R. KRUYT and JAC. VAN DER SPEK. (Communicated by Prof. E. COHEN).

(Communicated in the meeting of February 27, 1915).

1. When one of us[1]) carried out experiments with the As_2S_3 sol conjointly with C. F. VAN DUIN, it once struck us that a sol, which we had diluted to half its concentration, had retained nearly the same limit value. The object of the investigation communicated here was to endeavour to get some more knowledge as to the connexion between the As_2S_3 concentration and the limit value of the sol.

2. One may preconceive an idea as to this connexion. We assume for the moment that the sols differ only in concentration but not in the size of their particles. Now the limit value γ is the concentration at which so much of the coagulating cation is withdrawn by adsorption that the charge of the particles is diminished to a definite value differing but little from 0. Hence, the adsorbed quantity of cation (a) per particle is characteristic of the limit value. This again is connected with the concentration χ in cation in the solution after the congulation[2]) according to this equation:

$$a = k\chi^{\frac{1}{n}}$$

so that χ is, therefore, also characteristic of the limit value *but independent of the concentration of the sol.* As for the limit value γ we simply take into account the bruto-added electrolyte quantity, γ is as a rule not independent of the concentration.

In the Fig. 1 and 2 are represented schematically two sols in which the second has the double concentration of the first. When properly choosing the units we have in Fig. 1: $\gamma_1 = \chi + a$, in Fig. 2: $\gamma_2 = \chi + 2a$.

1) KRUYT and VAN DUIN, Koll. Beih. **5**, 269 (1914).

2) For fuller details compare KRUYT, Proc. **17**, 623 (1914).