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The Chemical Basis of Medical Climatology

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Chapter III

THE CHEMICAL TESTS

IN ORDER TO EXPLAIN what the chemical tests are I have decided to follow a course previously adopted with some success on occasion of the Brussels Symposium, October 1958.

When a chemical operation is performed and repeated several times, one will observe differences in the results obtained over a period. It is of course well known that our operations allow a margin of error that may be rather large or, on the other hand, rather small. This depends on the chemical system employed. The variations in the results are normally attributed to experimental errors; that is, to chance.

But the variations may be due, at least in part, to external causes, to conditions which have not been controlled and which exist and fluctuate independently of our wishes and about which we are generally unaware. How are we to determine their presence? The solution to this problem was attempted by devising an appropriate method, one capable of revealing how external phenomena influence our chemical operations.

Two possibilities were considered:

1) It is possible that, on modifying external conditions, the chemical system will react in a markedly different manner under the new conditions;

2) It is possible that, on modifying the chemical system, the system will react in a markedly different manner against the same external influences.

If the system reacts to one of these conditions, it is then possible to conduct a *differential experiment* by carrying out the same operation twice, simultaneously, using the same reactive agents and maintaining equal, at every moment, the common physical conditions of the two experiments at hand, (temperature, pressure, humidity, light, etc.), *but modifying* in an appropriate manner:

A) *The spacial conditions surrounding one of the two reacting systems,* or else:

B) *One of the reacting chemical systems.*

The results yielded by the two reacting systems will, as a rule, no longer be identical because of the imposed modification. It will be noticed, for example, that a more rapid sedimentation, a darker colour, a more abundant precipitation or some such effect will be evidenced by one of the two systems.

There will therefore be an observable difference, either *in one direction*—for example, a more rapid sedimentation in the modified system (or under modified conditions)—*or in the opposite direction.* It may also be that no difference whatever results but this case is extremely rare.

The case in which the sedimentation is produced more quickly in the modified system has been called *T,* while *R* is the name given to the inverse case. The case of perfect identity is known as *O.*

Experimental errors always play their part according to the chance involved (I am not considering the case of systematic errors) and superimpose themselves on the effects of external phenomena.

Pure chance, on a great number of experiments gives as results: 50%T. A result that on a great number of experiments is different from 50%, is always significant. Its value had to be that one observed or more different from 50%—that is to say—again better. *One derives from the differential experiment A RESULT THAT IS NOT DUE TO CHANCE, by effecting a large number of differential experiments (not less than 10) either simultaneously or within a very short space of time,* and by determining the relative number of the differences produced in direction T; that is, the percentage of T.

The percentage of T is the numerical result of the chemical test.

The result of the chemical test is therefore STATISTICAL and can vary from 0 to 100.

The principal feature of the chemical test is, therefore the following:

To provide a statistical numerical result, not by means of measurements, but by COUNTING the number of times, in a fixed *number of experiments, a given chemical operation behaves in a determined manner* with respect to another chemical operation of the same type.

The result of the chemical test is independent of temperature, pressure and so on; in short, it is *independent of all the common traditional variables.*

THE CHEMICAL TEST IN CASE A

External phenomena, far away or close at hand, manifest themselves in the space in which we live, as far as we know, by means of electromagnetic or corpuscular radiation or by field variations. Thus it is possible to modify the spacial conditions surrounding one of the two chemical systems in the differential experiment by enclosing the selected system in a metallic chamber or, at least, by placing a metal plate over it. The metal we have chosen is *copper.* The system is thus screened, either wholly (as in the case of the chamber) or in part (as in the case of the plate).

The copper screens, or at least partially screens, certain radiations and modifies the electrical and electromagnetic field.

If there are no forces acting in the surrounding space, or only those forces which are not modified by the copper, the response to the chemical test will be that due to chance: *50* (50% T).

But if in the surrounding space forces are acting that are modified by the copper, then underneath the plate (or within the chamber) the conditions will differ compared with those on the outside.

A sensitive chemical system will react to the difference in conditions during its evolution before reaching the equilibrium.

In this regard I will give two highly significant examples.

1) Polymerisation of Acrilonytrile

A solution of monomer acrilonytrile in water was divided and placed into several identical glass flasks. The flasks were enclosed in a small chamber or in a wooden chest, well protected against temperature variations. Half of the chest containing the half of the flasks was covered with a thin copper screen, 0.1 mm in thickness. After a sufficient length of time the flasks were taken out and the solid polymer that had formed was filtered, dried and weighed: From December 1951 to April 1954, 108 experiments were carried out and it was established that the weight of the polymer was *less under the screen* 80 times out of 108; that is, in 75% of the cases (Table III).

TABLE III

THE NUMBER OF EXPERIMENTAL GROUPS YIELDING A GREATER WEIGHT OF POLYMER

		Outside the screen	*Under the screen*
1951	December	7	2
1952	February	5	1
"	March	14	6
"	April	14	4
"	May	5	1
"	June	3	3
"	July	3	3
"	October	2	0
"	November	2	0
"	December	4	0
1953	January	8	4
"	February	10	0
1954	March	1	4
"	April	2	0
	Total	80	28
	%	74	26

From a statistical point of view, therefore, the effect of the screen was easily observable. The effect was *not constant either in sign or in size,* all of which is quite natural since spatial properties fluctuate incessantly.

2) Precipitation and Sedimentation of Oxychloride of Bismuth

a) 1000 Blank Tests

We hydrolised identical quantities of the same solution of trichloride of bismuth, with the same quantity of water, in two sets of beakers, designated by the colours red and blue. The hydrolisis was effected in pairs, one red beaker with one blue beaker, simultaneously and under identical conditions, 10 pairs at a time.

From October 15 to November 6, 1954, a total of 1000 paired tests was carried out.

In each group of 10 pairs, we recorded how many times the sedimentation of oxychloride of bismuth had proceeded more rapidly in the red beakers, and the percentage was calculated. This percentage constituted the numerical response to the blank test.

Distributing the different responses according to their values, between 0 and 100, a curve was obtained much like that of Gauss

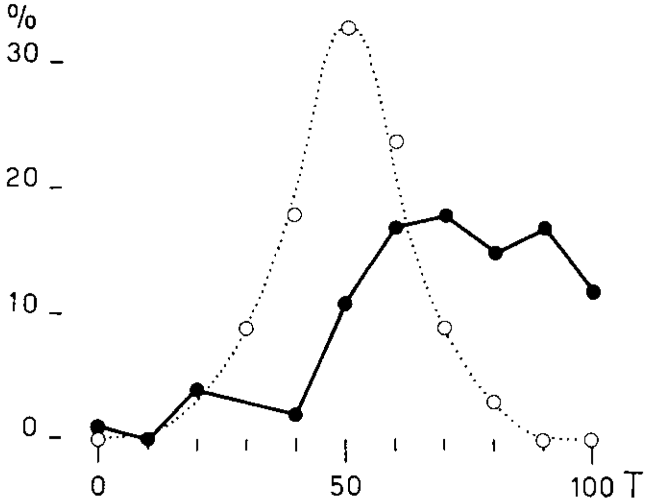

FIG. 1. One thousand *blank tests (dotted line)* and one thousand tests P *(black line)* effected in groups of ten, distributed according to the percentage T given by each group. On the abscissa: the values of percentage T; on the ordinate: the frequency of percentage T. Note the perfect symmetry of the distribution about value 50% in the case of the blank test and the dissymmetry of the distribution in the case of test P.

(Fig. 1), in symmetrical ratio to the ordinate 50. The general average of the 1000 results was 50.4%.

The blank test thus rendered the result due to chance.

b) 1000 P—Tests

Simultaneously with the blank tests, 1000 tests were carried out that were identical to those previous, *but the red beakers were covered with a copper screen.* This constituted *test P.*

Distributing the various results according to their values, between 0 and 100 a curve was obtained that was quite different from that of Gauss, showing an asymmetrical rapport with the ordinate 50. The general average of the results was 70.1%.

Test P therefore rendered a result quite different from that of the blank test. *This was no longer chance playing its part, but the influence of exterior actions.*

THE CHEMICAL TEST IN CASE B

One of the chemical systems may be modified by chemical or physical means. We have chosen, for practical reasons, a very simple physical means. Since the precipitation of oxychloride of bismuth, provoked by the hydrolysis of trichloride, was adopted for our routine tests, we modified the water by means of *physical activation.*

A bulb of mercury, that is, a closed glass globe containing a drop of mercury and neon at reduced pressure was gently stirred in the water. On moving the bulb, the mercury slides upon the glass; the double electric layer between the mercury and the glass is stripped and an electrical discharge is produced in the interior of the globe. The water which is in contact with the bulb is thus activated. Mercury bulbs as well as other devices, have been employed in industry for the "physical" descaling of boilers.

The mercury bulb has been the subject of a study by Halla and Novotny. The sliding of the mercury upon the glass produced an *electromagnetic emission.* This emission has not been found at high frequencies, but *only at low frequencies,* 3-4 KHz. But the low-frequency emission is modulated at an extremely small frequency, 10 Hz—that is to say, the 3-4 KHz emission appears in *packages* of 10 Hz. It is useless at this point to speak of the physical-chemical problems that activation presents: the structure of water etc. It is enough to know now that it is possible to prepare two lots of water, chemically identical (of the same centesimal chemical composition), but physically different.

With *normal water* and *activated water* we are able to conduct a *differential experiment* as in case B and to use it as a chemical test.

Such a test may be conducted *out of doors,* in the open air; that is to say, in a location where there is no metal present. This constitutes test *F*. On the other hand, the test may be conducted *indoors,* within an area shielded by copper (or underneath a screen). This constitutes test *D*.

THREE CHEMICAL TESTS

The three types of chemical test which we have employed up to the present are collected in the Table IV.

TABLE IV

(I is compared with II)

	Condition I	*Condition II*
Test P	normal water spacial conditions unmodified: open air	normal water spacial conditions *modified:* under copper
Test F	normal water spacial conditions unmodified: open air	*activated* water spacial conditions unmodified: open air
Test D	normal water spacial conditions *modified:* under copper	*activated* water spacial conditions *modified:* under copper

RESEARCH ON THE CHEMICAL TESTS

With regard to the chemical tests, two types of research were carried out:

a) *Special research,* designed to improve our knowledge of the chemical tests.

b) *Routine research,* given to the study of exterior actions, with which we deal later.

Special Research

1) *Closed and Open Metal Screen (Completely Sealed Copper Chamber and Horizontal Copper Plate)*

It was very important to know if, instead of working within a completely sealed copper chamber, we could obtain results that did not differ too greatly by working under a copper plate. This was necessary since we had to conduct routine tests in places where it was impossible to employ a sealed metal chamber.

TEST D—Three series of 200 differential precipitations (normal water-activated water) carried out in May 1953, one in the open air, one beneath a horizontal copper plate and one in a sealed copper chamber (thickness of the copper of the chamber and the plate: 0.1 mm), yielded the results collected in the Table V.

TABLE V

	% *T*
In open air	54.5
Beneath the plate	37.0
Within the chamber	37.5

Thus there was no great difference between the two tests D. We may safely assume that exterior forces fall downward upon the Earth from above. Therefore the "roof" would be the most important part of the chamber for the purposes of the chemical tests. All of this has only an indicative value since the tests were so few.

TEST P—Five years later (1958) it was observed that test P followed a different behaviour pattern from that followed by test D. The results of test P obtained by using a horizontal metal plate showed a behaviour almost *reversed* to that shown by the results of test P obtained simultaneously using a completely sealed copper chamber.

This explains why the test P results obtained in Florence using the copper chamber have shown a positive and significant correlation with solar activity, while the results obtained in different stations during the IGY, when of necessity simple copper plates were employed, have shown a negative and significant correlation. The screen obviously plays a very important part in the chemical tests.

The problem of the screen is highly complicated and requires a separate study. On the other hand, how are we to compare the results of the experiments carried out in 1953, with a near-minimum of solar activity, with the results of the experiments carried out in 1958, with a near-maximum of solar activity? Variations in solar activity must be closely considered in this study.

2) *Nature of the Metal of the Screen*

Numerous series of tests were carried out, activating water and precipitating oxychloride of bismuth within small chambers of different metals—copper, aluminium, iron and lead—so as to determine whether the nature of the screen was of importance, that is to say if the action of the screen was merely electrostatic, or if it was comparable to the action of a filter or selective mirror.

The results of four series of 6,900 tests each (normal water-activated water) carried out between January 6, 1954 and March 26, 1955 are collected in the Table VI general averages.

TABLE VI

	% T	*Specific electrical conductance ohms^{-1} cm^{-1}*
In open air	46.4	0.10^4
Under Fe	45.4	10.
Under Al	42.2	35.
Under Cu	39.6	58.

It is evident that the nature of the metal plays an important rôle. We may conclude that the most important characteristic of metal, as far as the chemical tests are concerned, is its electrical conductivity. Unfortunately, physics has nothing to tell us on this subject. What we know regarding Faraday's cage is valid for electrostatic phenomena, but not for the phenomena which we are studying, where an entire range of electromagnetic waves falls on our screens.

3) *Structure of the Screen*

Since we have not only the nature of the metal to consider, but also the structure of the screen, we have carried out some orienting tests with a *compact screen*—a continuous metal plate—and a *discontinuous screen or powder screen*—a metallic paint: that is, a metallic powder bound by an insulating paint.

We have tried out an aluminum plate with a thickness of 0.7 mm and a piece of cardboard coated with a "*pure aluminium paint.*" Three series, each of 500 simple tests (three single precipitations): one in the open air, one beneath the painted cardboard and one beneath the plate, were carried out between April 7, 1955 and April 14, 1955. The three series were later compared, and give the results collected in the Table VII general average.

TABLE VII

	% T
Out of doors—with plate	76.8
Out of doors—with powder	72.6
With plate—with powder	45.6

It is evident that the screen formed by a metallic powder with isolated grains also produces a noteworthy effect, almost like that produced by the metal plate.

But this depends upon the radiation falling upon the screen. It was noticed much later that the aluminium plate screened to a noticeable extent the radioelectric emission of 10 KHz frequency, but that the cardboard presented hardly no obstacle to the same emission. So then, which rays are stopped by the discontinuous screen? This problem as well should be studied by the appropriate methods. It is a matter of experimenting with very different frequencies, above all with the very low frequencies (VLF), ones for which we can find no serviceable instrument, either transmitter or receiver. It would be necessary to build them all specially.

The problem of the screens is slowly being forced upon us.

4) *Test D, Test P and Screen Thickness*

In order to establish whether the screen played an important rôle in our tests, a long series of tests was carried out, activating water within lead boxes of different thickness: 0.3, 15 and 30 mm.

Between June 25, 1953 and April 10, 1954, 7130 tests were carried out using the chamber of 0.3 mm thickness, and 7130 with the chamber of 30 mm thickness. From January 26, 1954 to April 10, 1954, 1500 tests were carried out using the chamber of 15 mm thickness, contemporaneously with those for the 0.3 and 30 mm chambers. The results are collected in the Table VIII.

TABLE VIII

	Pb 0.3	*Pb 15*	*Pb 30*
Series of 7130 tests	39.7	----	42.9
Series of 1500 tests	40.4	42.9	41.4

The effect of thickness is not very remarkable for the thicknesses and metal in question, even though the thickness was varied from 1 to 100. The general pattern seems to follow Rossi's curve, because the 15 mm screen yielded results a bit greater than the 0.3 and 30 mm screen. But this does not help much in the study of our chemical tests. If that which was observed comes within the sphere of interactions between *cosmic radiation* and *dense screens* and becomes a problem of secondary radiation, then the dense screen, of great thickness, presents nothing but a useless complication, voluntarily introduced. We then attempted to discover if an *extremely thin screen* had an influence on the chemical tests, hoping to be able to establish a *minimum limit* for practical thickness.

Aluminium screens were placed on cellophane by sublimation in a vacuum, and were employed according to the test P technique. Very noteworthy effects were constantly obtained, even with screens which were so thin (800 angstrom) that they allowed the filtration of a weak blue light when held up to an electric lamp. This result agrees with those obtained by Bortels on biological tests. A very thin sheet of aluminium foil, like that from cigarette packages, was enough to produce notable effect on the microbiological system.

In addition, three series of 100 simple tests were carried out according to the test P technique, simultaneously precipitating oxychloride of bismuth in the *open air,* underneath a screen of *hammered gold* (gold leaf used for the gilding, 0.5 thousandths of a millimeter in thickness, applied to cardboard), and underneath a screen of *gold deposited by sublimation* on cellophane (8-10 gr. of gold for 10 square meters of surface, about 50 angstrom in thickness). The results which were obtained are collected in the Table IX.

TABLE IX

	% T (General averages)
Open air—deposited gold	45.0
Open air—hammered gold	71.0
Deposited gold—hammered gold	76.0

It is evident that the hammered gold shows a very noteworthy difference out of doors while the deposited gold reveals a slight and negative effect. Forty-five is not far from fifty, which would be the result due to chance. On the other hand, a mere 100 tests does not permit us to draw any definitive conclusions. All the same, it is obvious that a very noteworthy effect may yet be obtained with thicknesses less than one micron.

With regard to the chemical tests, it will be necessary to pursue the study of the effects of screens of very small thicknesses. This area is completely new, even from the point of view of the interaction of screens on electromagnetic fields.

5) *Electromagnetic Fields of Very Low Frequency (VLF) and the Chemical Tests*

Natural electromagnetic fields of radioelectric frequency present a rather particular point of interest, for they are capable of quite visibly influencing colloidal systems in evolution, if the frequency is sufficiently small. It would have been highly interesting to have correlated the results of my chemical tests with the intensity of *atmospherics* (VLF). But in Italy the intensity of atmospherics was not measured; to have made use of information from Munich or Hamburg and so forth, places very far from Florence, would not have made sense.

So two series of simple tests were carried out, one at a distance of 2m and the other at a distance of 20m from a transmitter with a strength of 10 W, regulated on a frequency of 10 KHz. At 20m the intensity of the electro-magnetic field, measured by a field meter, was a great deal weaker than at 2m. Ten simultaneous pairs of precipitations of oxychloride of bismuth were effected in the normal manner; we then counted how many times the sedimentation proceeded more rapidly far from the transmitter.

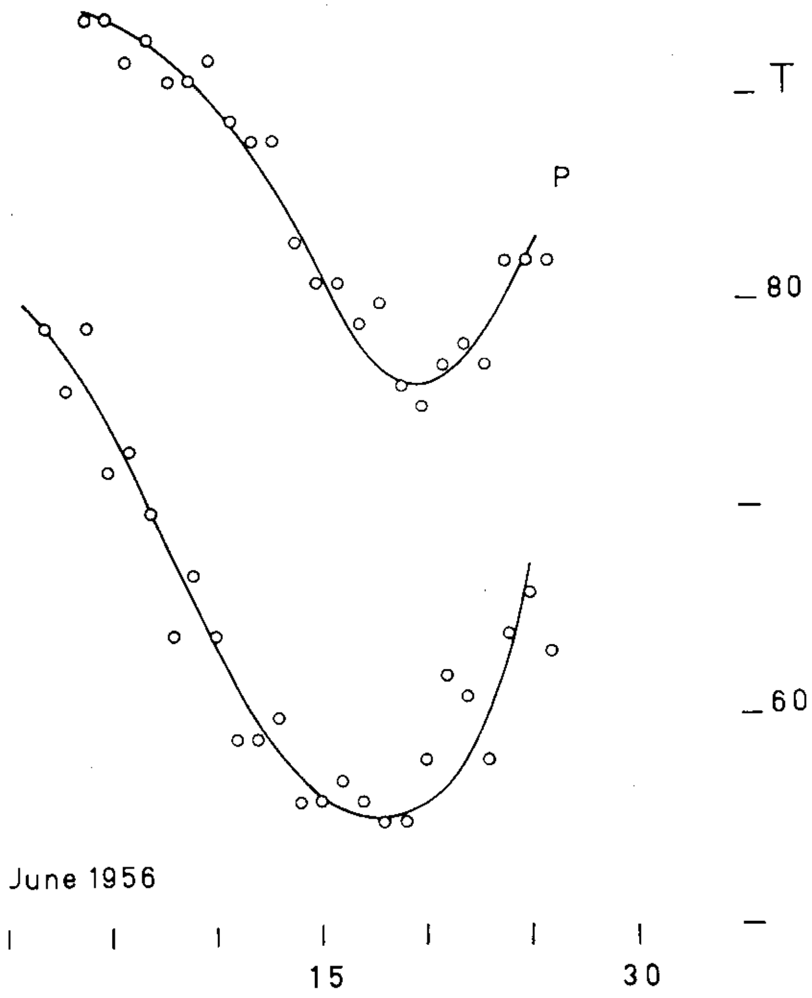

Fig. 2. *Above:* the behaviour of test P in June 1956 (screen effect). *Below:* the behaviour of the near-far chemical test under the influx of an electromagnetic field of 10 kHz frequency. Note the parallelism.

It was therefore a case of a *near-far test* perfectly analogous to test P, which is an *indoors-outdoors test.*

From September 11, 1955 to February 29, 1956 ten simultaneous pairs of precipitations were effected each morning at 9h 30, for a total of 1720 pairs.

At 20m, the sedimentation of oxychloride of bismuth proceeded more rapidly in 72.7% of the cases. The sedimentation was thus, on the average, retarded during the period in question by the effect of the electromagnetic field.

The tests were continued between June 1, 1956 and June 25, 1956 using two different frequencies: 10 and 120 KHz, and effecting 260 pairs of precipitations for each frequency. The two series of tests yielded practically the same results. The pattern of the near far response for both the 10 KHz and the 120 KHz frequencies, was almost parallel to that of test P (Fig. 2).

There is no doubt that electromagnetic fields play a very important rôle in the chemical tests.

6) Effect of Altitude on the Chemical Tests

It was rather necessary to know, from a general point of view, if the altitude of the location where tests were carried out was of any importance, so as to be able to compare results obtained in different places.

Prof. Fritsch of the Vienna Technical High School (Technische Hochschule Wien) organized studies, in collaboration with us, at Kaprun Mooserboden, altitude 2000 m, and Kaprun Werksiedlung, altitude 800 m, on the Hohentauern (Austria), during the construction of the great hydroelectric dams, from May to December 1954.

Other studies were carried out over a six-month period from October 1957 to March 1958 by the personnel of the Astronomical Institute of the University of Tuebingen, directed by Prof. Siedentopf, at Jungfraujoch (3578 m) and at Tuebingen (328 m). The total results are collected in the Table X.

TABLE X

	Altitude	*% T (General averages)*		
		F	*D*	*P*
Kaprun Werksiedlung	800	48.6	51.9	. .
Kaprun Mooserboden	2000	55.0	54.7	. .
Tuebingen	328	38.3	45.4	64.0
Jungfraujoch	3578	47.3	54.3	43.2

While at Kaprun very small differences were observed between the tests effected at 2000 m and at 800 m, the Jungfraujoch tests revealed much higher values for tests F and D and lower values for test P than was the case at Tuebingen.

It must, however, be kept in mind that the Kaprun tests were conducted in 1954—that is, during the *minimum* of solar activity —while the Jungfraujoch tests were conducted in 1957 and 1958, during the *maximum* of solar activity. Furthermore, we must remember that Jungfraujoch is 1,500 meters higher than Mooserboden. A perfect solution would demand being able to carry out still more tests, during both a minimum and a maximum of solar activity, in the same place and using identical methods.

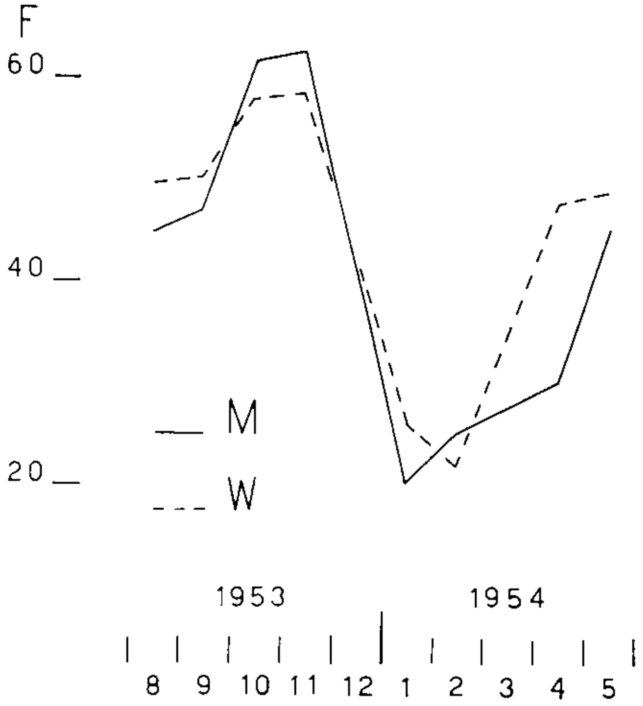

FIG. 3. Chemical test F at Vienna and at Kaprun Mooserboden from October 1953 to May 1954 (monthly averages). *Dotted line:* test F at Vienna Untertullnerbach (altitude 280 m). *Black line:* test F at Kaprun Mooserboden (altitude 2000 m). The distance betwen the two places about 290 km. Note the similarity of the behaviour.

It is interesting to note that the behaviour of the tests F and D at Kaprun Mooserboden and in Vienna was practically the same notwithstanding the distance between the two stations (300 km) and the difference in sea level (1800 m). The tests obeyed a general phenomena (Fig. 3).

7) *Diurnal Effect*

It seemed reasonable to wonder if there existed a diurnal effect, but because of the difficulties involved in carrying out continuous tests during the night (every night for several months), I have deferred such a study.

At the Tuebingen Astronomical Observatory, directed by Prof. Siedentopf, Dr. U. Mayer carried out tests at noon and at midnight during the months of May, June and July, 1958 for a total of 860 differential precipitations at noon and 780 at midnight. The results are collected in the Table XI.

TABLE XI

Tuebingen	*Day-night % T (Monthly averages)*					
	DAY			NIGHT		
1957	F	D	P	F	D	P
May	32.8	60.0	23.3	36.7	63.3	13.3
June	42.1	55.2	45.7	45.0	58.8	49.4
July	38.0	48.8	39.7	39.7	52.3	39.3
Averages	37.6	54.7	36.2	40.4	58.1	34.0
Brussels						
1958						
August-September (total averages)	59.6	54.3	56.3	56.0	55.0	47.1

I have obtained this data privately from Miss Mayer.

According to the Tuebingen results, it would seem that there is no noteworthy day-night effect. But the problem of diurnal variation must be studied further. It cannot be resolved with only two series of experiments a day. Madame Capel, who has conducted night-time tests at Uccle-Brussels, plans to resume this line of study at an opportune moment.

8) *Effect of Turbulence*

The attention of many scientists is today being drawn toward the *plasmas*—the fluids made up of electrically charged particles: positive ions and electrons. In the field of astrophysics, the atmospheres of stars, interstellar matter, nebulous gasses and comets are considered as being plasmas. In the fields of physics and physical-chemistry, metallic liquids and flames (above all salted flames, the flames of the electric arc etc.) are considered as being plasmas. It is not yet known if an electrolytic solution could be considered as being a plasma of a particular type.

Today a plasma theory has been developed (Alfven and others) which has also led to laboratory experiments which are opening up a new field: *Magnetohydrodynamics.* Magnetohydrodynamics is the study of the movement of an electrical conductor fluid in a magnetic field. The electrical currents resulting from the movement modify the field and, at the same time, as they flow in the magnetic field, produce mechanical forces which modify the movement of the fluid.

Since water, saline solutions and colloidal solutions are also fluids containing electrically-charged particles, it was expedient to establish whether the movement—the turbulence—of a liquid such as water was an important or an insignificant factor in our chemical tests.

To this end we effected, between March 19 and April 12, 1955, three hundred pairs of differential tests with water which had remained *motionless* for a long time, under a cardboard screen and under a copper screen. The precipitations were carried out in the open air. The general average was 50.0—the result due to chance.

Between March 19 and May 14, 1955, we carried out 350 pairs of differential tests with mechanically *stirred* water in two flasks, one inside a cardboard box and the other inside a copper box. The precipitations were carried out in the open air. The general average was 56.8. This was no longer chance. There had been a slight effect.

Between April 28 and July 15, 1956, we carried out a further 790 pairs of differential tests with water which was agitated by bubbling in two flasks, one inside a cardboard box and the other inside a copper box, both with the same modality. The general average was 54.4. Once again we were able to note an effect, slight but meaningful.

The daily data *smoothed out* over decades, vary between 45 and 55 and their fluctuations correspond perfectly with the fluctuations of test P (on another scale, of course). This demonstrated that the same factors that have influenced test P have influenced our experiment (Fig. 4).

Our experiments have thus revealed something highly unusual: *agitation—or turbulence—seems to be capable of determining the effect of the screen in the water.* But this is only the beginning. Unfortunately, the problem of the screens still has to be studied.

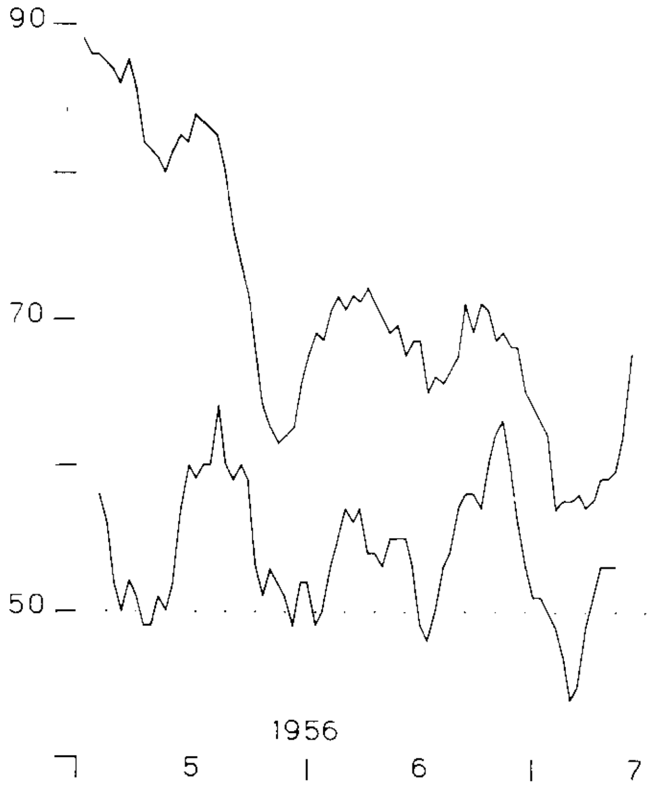

FIG. 4. *Above:* Test P. *Below:* test water stirred under cardboard—water stirred under copper. *On the abscissa:* the time. *On the ordinate:* the percentage of the two tests. Daily averages smoothed by ten.

The Routine Research

After having shown the results of studies specially conducted with the aim of understanding the properties of the chemical tests and of setting out the problems that will have to be resolved in the future, we may speak of the routine tests, conducted in Florence, at the Institute of Physical Chemistry of the University, with the particular aim of establishing whether the chemical tests respond to exterior actions and, in the affirmative case, whether it is possible to determine which are the external phenomena which influence the results of the chemical tests.

First I will set out the sum of the work carried out in this sphere (Table XII).

TABLE XII

Number of Tests Conducted Between March 1, 1951 and October 31, 1960:

Florence	*8^h30^m*	*14^h30^m or 12^h00^m*	*18^h30^m*	*Total*
Test F	36035	35710	19350	91095
Test D	36038	35709	19350	91097
Test P	22150	22110	18110	62370
Test P IGY	....	12880	....	12880
			General total	257442

The figures concern the period from March 1, 1951, to October 31, 1960, a total of nine and a half years. The routine tests F, D and P were conducted every day, including holidays.

Beginning October 1, 1952, routine tests were initiated at Brussels by Madame Capel Boute, Chef des Travaux at the Institute of Electrochemistry and Metallurgy of the Université Libre, with the assent, assistance and advice of M. Decroly, Director of the Institute. Since July 1, 1957, studies have been carried out, thanks to the kindness of M. Bourgeois at the Belgian Royal Observatory, in a tiny wooden pavilion that has no metal constituents.

Beginning February 13, 1953, routine tests were carried out at Untertullnerbach, near Vienna, at the Wiental-Wasserleitung, thanks to the kind interest of engineer H. Doat, Director of the W. W. Society. The tests were interrupted on December 31, 1955, because the W. W. was taken over by the City of Vienna. It was truly unfortunate that a series of tests that had gone on for four years should be interrupted right in the middle of the IGY.

During the IGY and the subsequent IGC (International Geophysical Cooperation) routine tests were put into operation in several localities in the world (Table XIII).

TABLE XIII

Brussels (Uccle)—Observatoire Royal de Belgique.
Tuebingen—Astronomisches Institut der Universitaet.
Jungfraujoch—Meteorological Observatory.
Vienna (Untertullnerbach)—Wiental Wasserleitung.
Triest—Osservatorio Geofisico Sperimentale.
Genoa- -Instituto Geofisico e Geodetico dell 'Università.
Bari (Castellana Grotte)—Distaccamento dell 'Istituto di Fisica dell 'Università.
Libreville—Service Météorologique du Gabon.
Leopoldville—Service Météorologique du Congo et de Ruanda Urundi.
Fort Dauphin—Services Météorologiques de Madagascar, des Comores et de la Réunion.
Kerguelen Islands—Etablissement Scientifique du Territoire des Terres Australes et Antarctiques Françaises (T.A.A.F.).

Sapporo- -School of Medicine, Department of Physiology, Hokkaido University.
Kumamoto—Research Institute for Diathetic Medicine, Department of Physiology and Hygiene, Kumamoto University.
Nouvelle Amsterdam—Etablissement Scientifique du Territoire des Terres Australes et Antarctiques Françaises (T.A.A.F).
Base Roi Baudouin (Antarctica)—Etablissement du Centre National de Recherches Polaires de Belgique. 2. eme Expedition Antarctique.
Tromsoe—Nordlysobservatoriet.

The data gathered at Florence has been studied both by myself and by specialists: Prof. O. Burkard, University of Graz; Dr. Becker, Fraunofer Institute, Freiburg i/B; Dr. Mosetti, Geophysical Observatory, Trieste; Prof. Berg, University of Cologne; Dr. U. Mayer, University of Tuebingen.

The relationship between test D and solar activity immediately became evident. Nonetheless, it was necessary to establish statistically its degree of accuracy and to uncover any other relationships that might not appear so openly. It is in this area that the work of the above-named specialists has been so valuable. The following is a summary of the results they have attained.

TEST D

Secular Variation. The annual, monthly and daily averages reveal a secular variation, marked by a very low minimum in 1954, in perfect correspondence with the minimum of solar activity (Fig. 5). Becker has demonstrated that this correspondence is statistically valid.

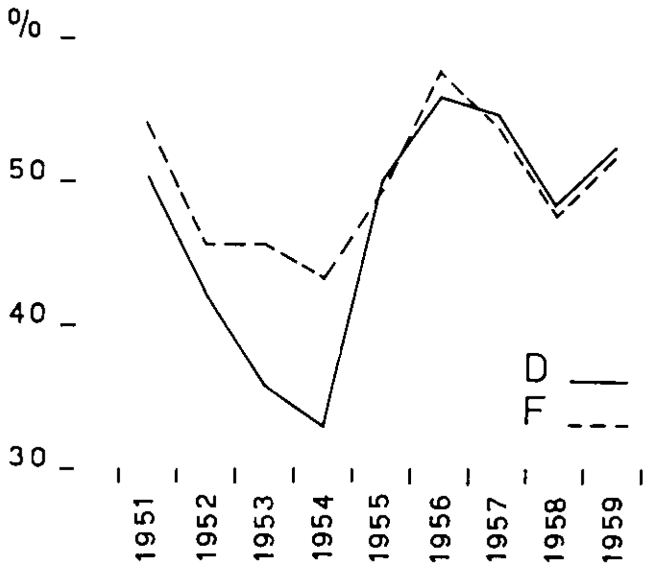

FIG. 5. Secular variation of test F (dotted line) and test D (black line). Annual averages. *On the abscissa:* time in years. *On the ordinate:* the percentages F and D. Note the minimum in 1954.

Annual Variation. One observes an annual variation marked by a very low minimum, corresponding to the month of March (Fig. 6). Also noticeable is a secondary minimum which corresponds with the month of August. Becker has demonstrated that the March minimum is real and that the August minimum is no longer so. We must wait until we have more information. But today, after ten years, the August minimum exists always and we can consider it. The existence of an annual rhythm leads one to envisage a relationship between the result of test D and the movement of the Earth. I will return to this point later.

Short-term Variation. These variations, often very marked, may be connected with different phenomena. During the long periods a parallelism was ascertained between the behaviour of test D and

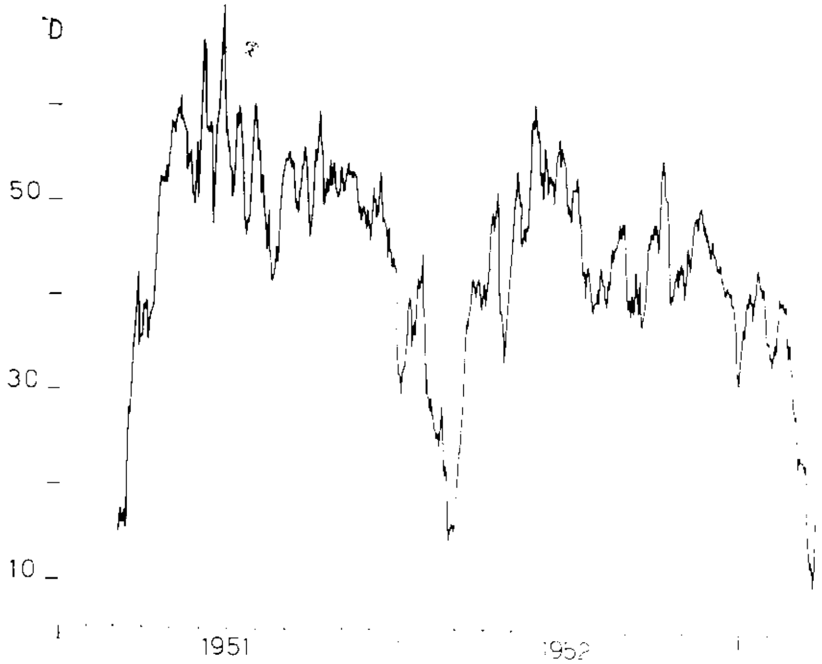

FIG. 6. Annual variation of test D. Daily averages smoothed by ten. *On the abscissa:* the time. *On the ordinate:* test D. Note the winter-spring minima.

the intensity of the cosmic radiation recorded by Prof. Steinmaurer at Hafelekar, near Innsbruck (Fig. 7). However, it has not been possible to pursue these studies at any length. The emission of particles from the sun is related to the solar activity.

TEST F

Secular Variation. Test F reveals a highly evident secular variation, although it is less marked than that of test D (Fig. 5). The variation also reveals a minimum which corresponds with 1954, but not as low as that of test D. The secular behaviour of test F appears disturbed. This should not be surprising, for test F is not protected, as is Test D, against natural electromagnetic fields. Becker has demonstrated that the general relationship between test F and solar activity is statistically valid.

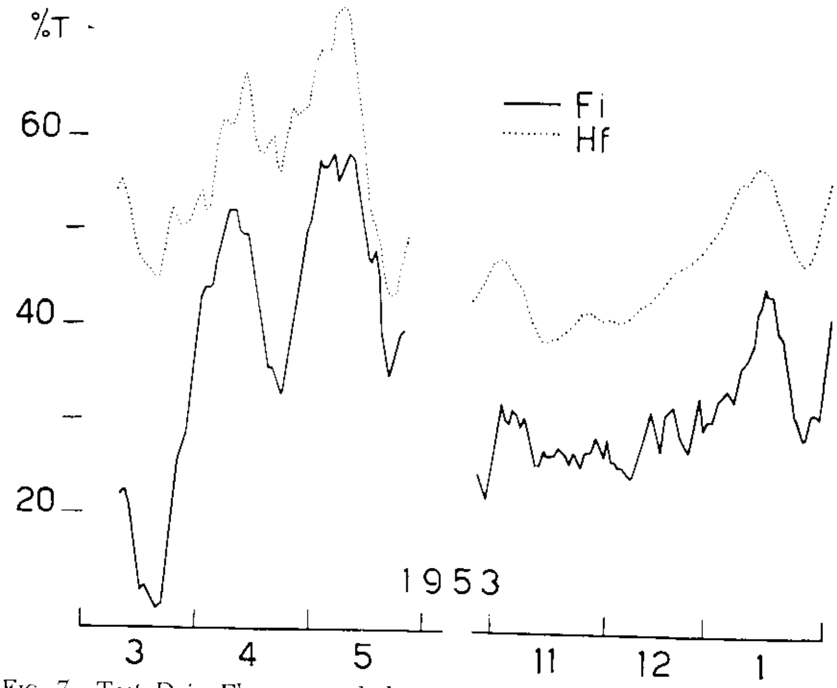

FIG. 7. Test D in Florence and the intensity of cosmic radiation on the Hafelekar (Innsbruck) during two periods of three months each. *On the abscissa:* the time. *On the ordinate:* test D and the intensity of the cosmic radiation (on arbitrary scale).

Annual Variation. Test F in the years of rare sun activity reveals an annual sinusoidal variation which differs greatly from that of test D. The minimum occurs in summer, the maximum in winter. This variation has been studied by Becker. In the years of great activity the behaviour of test F results not too differently from those of test D.

Short-term Variation. Test F reveals short-term variations which may be connected with different phenomena. Becker has demonstrated the existence of a very brilliant effect of *solar eruptions* and Burkard has revealed the existence of an effect of magnetic storms.

TEST P

Test P has been studied both by Becker and by Mayer. I can only list very briefly the information with which they have privately furnished me. These authors have not as yet published their results, which are quite recent. I will merely say that *test P must also be connected with solar activity*. The results of correlation are significant and positive for the Florence test. Test P has yielded significant and negative results in other localities. As I have said before, only in Florence do we utilise a completely sealed copper chamber. The other stations use nothing but a simple copper plate with which they cover half of the beakers in which the hydrolysis of oxychloride of bismuth is taking place. As we have said, the problem of test P is related to the problem of the screens.

Since laboratory tests have demonstrated that electromagnetic fields of relatively low frequency influence the flocculation and the sedimentation of the oxychloride of bismuth, it would also be necessary to relate the result of test P to the *atmospherics* or, in general, to terrestrial, solar and cosmic *radioelectric emission*. It would consequently be necessary to further relate it to the state of the ionosphere, that is to say, to solar phenomena. Everything is bound up in an incessantly-fluctuating whole.

THE COMPUTATION OF THE RESULTS

We have counted always the results, as we have said before. Upon the suggestion of Prof. Van der Elst, Mrs. Capel Boute has examined the possibility of increasing the results obtained by normal method without doing other chemical operations.

It is enough, in effect, for this to be able to note the succession order of the sedimentations in each series of different experiments.

Van der Elst had ascertained mathematically that one can also obtain for N pair of simultaneous precipitations N^2 results, but of those results only 2N-1 were independent.

One of the two successive operations standardised for the IGY research consist of 5 pairs of simultaneous precipitations for each test, and they were capable of giving 2.5-1 9 results instead of 5. Totally: 18 results instead of 10.

To realise this appreciable gain in the statistical field from daily results, without making new precipitations, Mrs. Capel Boute added a system which aided in establishing the order in which the sedimentations came. The data obtained from Van der Elst's method were called *complete results*, the normal data were called *diagonal results*.

The observation and calculation of the complete results in Brussels was made from December 1, 1957, until September 30, 1958. From a comparison of the diagonal with the complete data it was apparent that they give practically the same results. Our first method of counting was also good. We could therefore continue to use the normal method.

CHEMICAL TESTS AND TEMPERATURE

The routine experiments have given us a way of determining over a long period of time if the great fluctuation of the chemical tests depends upon the variations of the temperature of the environment. The great fluctuations of the chemical tests are *independent* of the temperature variations (Fig. 8).

In spite of the extreme complexity of the research, in spite of difficulties with regard to material and personnel, the chemical tests have yielded results that are very precise and very clear.

This is the first time that a very commonplace chemical operation, conducted according to a new method, relative and statistical, has provided the means of discovering whether important phenomena are taking place in surrounding space and, above all, on the Sun.

And, finally, *it is the first time that it has been possible to ascertain, by chemical means, whether something is disturbing our colloidal systems in evolution and, consequently, our biological systems.*

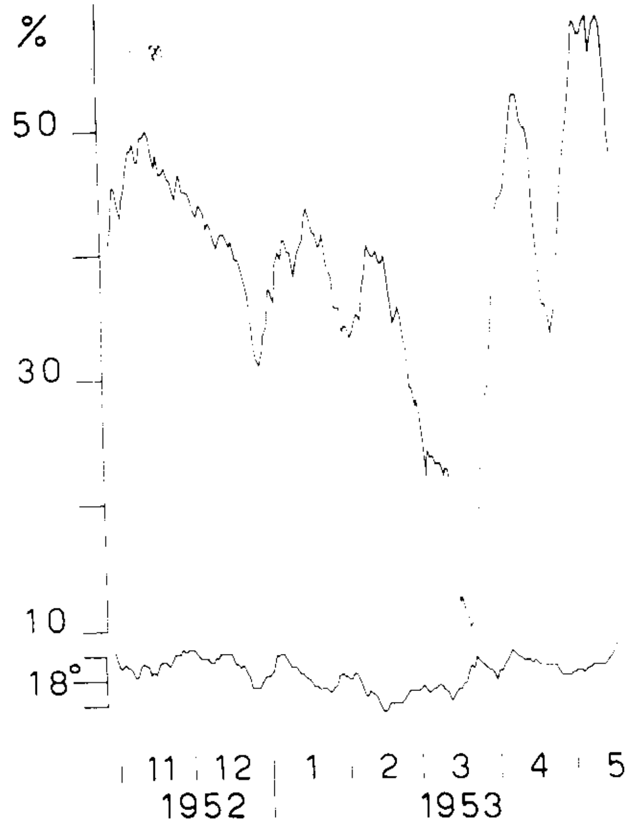

FIG. 8. Test D and the temperature of water during seven months. *Above:* test D. *Below:* the temperature of water. Daily averages smoothed by ten. The temperature of water fluctuates between two degrees (17 and 19°C). There is no correspondence between temperature and test D.

In figures 9, 10, 11 and 12 are shown the monthly averages of test F and D over ten years and three series of daily averages of test P.

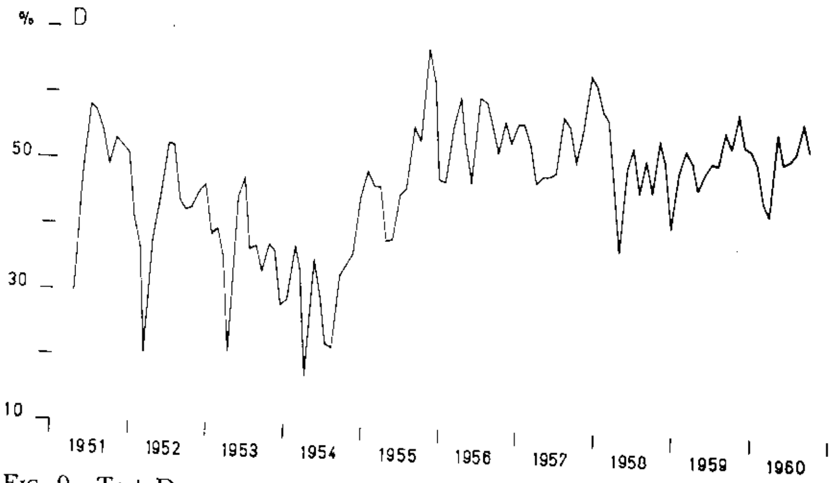

FIG. 9. Test D over ten years. Monthly averages. *On the abscissa:* the time. *On the ordinate:* test D. Note the secular variation.

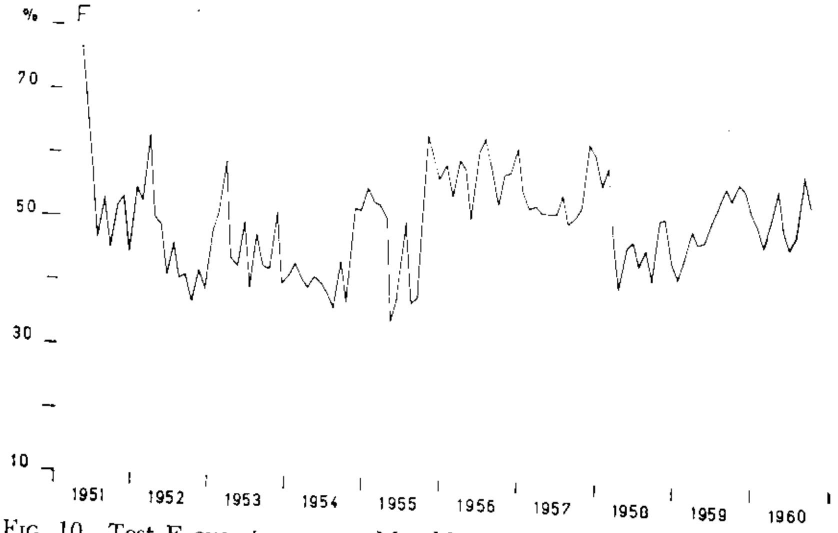

FIG. 10. Test F over ten years. Monthly averages. *On the abscissa:* the time. *On the ordinate:* test F.

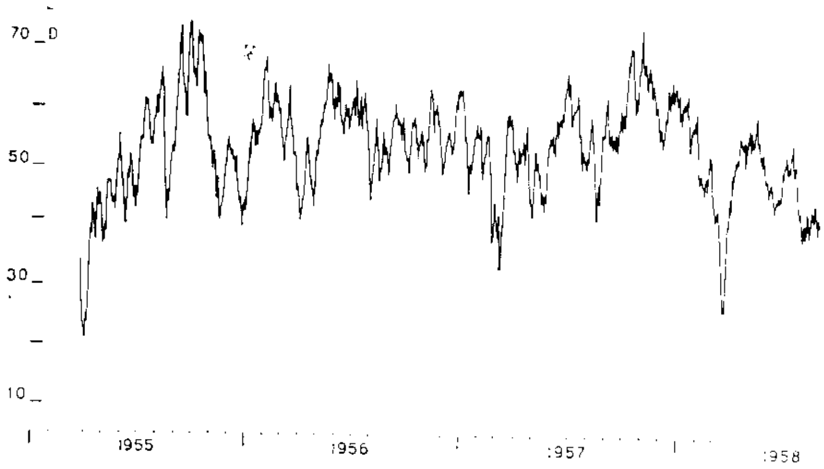

Fig. 11. Test D during the large resurgence of solar activity. Daily averages smoothed by ten. *On the abscissa:* the time. *On the ordinate:* test D.

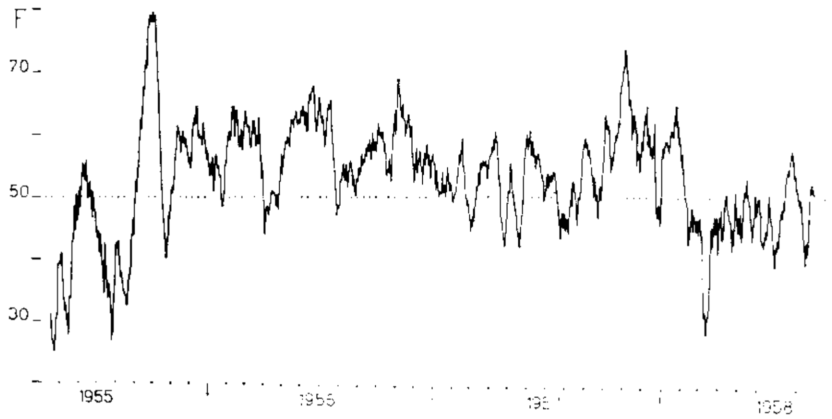

Fig. 12. Test F during the large resurgence of solar activity. Daily averages smoothed by ten. *On the abscissa:* the time. *On the ordinate:* test F.

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POLYMERIZATION AS A CHEMICAL TEST

The Polymerization of the Acrylonitryle as a Chemical Test

New and more precise experiments on acrylonitryle were carried out in 1960, according to the test P techniques.

A single solution of acrylonitryle in water, to which was added the proper quantity of potassium persulphate as an activator, was divided in equal measure into 20 flasks. Ten flasks were placed in a blackened cardboard box and the remaining ten were placed in a copper container which was likewise blackened and which was identical in shape and dimensions to the first. The two containers were then put into a double-walled cardboard box which was later wrapped in a layer of wool for better insulation. It was verified that the apparatus assured the same thermic history in the two containers (between 0.1° C). After 24 hours the boxes were opened and the polymer which had formed in the flasks was filtered, dried and weighed. The surface tension of the clear liquid was measured.

The surface tension of an aqueous acrylonitryle solution lessens as the quantity of monomer acrylonitryle present in the solution increases. Polymer acrylonitryle has no effect on surface tension. For this reason, the measurement of surface tension tells us how much monomer acrylonitryle has remained in the solution and thus *how* much acrylonitryle has been polymerized.

Since the polymer is hydrated, the quantity of water remaining on the polymer varies depending on the length of the polymer molecules: many short chains hold more water than fewer long chains, the amount of polymer acrylonitryle being the same, because a greater number of heads is involved. The *gross weight* of the polymer may thus vary depending upon the manner in which it is polymerized, even though it contains the same quantity of acrylonitryle.

The weight of polymer and the quantity of acrylonitryle polymerized do not necessarily correspond. For this reason we have taken both figures into account, the weight of the polymer and the quantity of acrylonitryle polymerized.

The thermostatic cardboard box was placed in a room situated on the first floor of our Institute, just below the roof, which is of wood and terra cotta and contains no noteworthy metal components, and therefore not able to screen appreciably the atmospherics. This was verified with an appropriate instrument.

Everything was arranged so that after 36 hours the quantity of polymer formed should not amount to more than half of the monomer introduced, and so that it should, indeed, be considerably less.

At first, we considered only the weight of the polymer formed. The study of the fluctuations in the quantity of acrylonitryle polymerized (measured by surface tension) was postponed until a later date.

For the sake of simplicity we noted *the total weight* of the polymer acrylonitryle obtained from the 10 flasks in the cardboard box and the 10 flasks in the copper container; we then counted *how many times in the space of one month the quantity of polymer had been greater in the copper container* and related the result to 100. In this way, the operation came to correspond to a true and proper test P.

In the room under the roof, the temperature varied considerably from one day to another and with the arrival of the first summer heat it was often necessary to reduce the quantity of persulphate added to the solution so that the polymerization would not take place too rapidly, reaching a total polymerization of monomer. This did not invalidate the differential method.

The percentage of times that a greater weight of polymer was obtained in the copper container in the course of a month *varied over the months.* The patterns of the monthly percentages relative to the polymerization under the roof were also parallel to that of inorganic test P(oxychloride of bismuth).

This means that the very actions that had modified the polymerization process had also modified the precipitation of oxychloride of bismuth.

One sees that these actions had to be a certain duration, because the process of polymerization as desired by us is very slow. In spite of this, the total result was practically the same as that of the inorganic test P.

Since the duration of polymerization may be controlled at will, we are able, by employing acrylonitryle, to obtain tests which integrate the effects of external forces in the best possible way.

Polymerization and the Low-frequency Electromagnetic Field

In Chapter III we referred briefly to the subject of polymerization of acrylonitryle in an aqueous solution, treating the problem as one does a problem of natural science. We tried to show how the phenomena which take place in the space which surrounds us act upon the polymerization of acrylonitryle.

It is not hard to admit to a perceivable influence due to spacial phenomena; the free radicals play a very important role in the polymerization of many substances. We know that free radicals of water prime the polymerization of acrylonitryle. These radicals are generated not only by appropriate chemical reactions (e.g., hydrogen peroxide + ferrous sulphate) and by other physical-chemical processes, but also by ionizing radiations.

It is enough to know then that the ionizing radiations originating in surrounding space can reach the Earth, in order to concede that the *polymerization of acrylonitryle will always be subject to spontaneously established conditions* which are beyond our control, and which *fluctuate incessantly.*

However, natural phenomena *other than ionizing radiations* can influence the process of polymerization. One can demonstrate the existence of this influence in a rather general way by conducting tests outside of and within a thin copper screen.

Piccardi and Cini have studied at length the influence exercised by a low-frequency electromagnetic field (10 kHz) on the precipitation of oxychloride of bismuth and they wanted to study the influence of the same low-frequencies on the polymerization of acrylonitryle.

The new experiments were routine and for this reason they were standardized.

Solution A: Monomer acrylonitryle (Badische-Anilin und Soda Fabrik) dissolved in distilled water, in the proportion of 60 ml per litre of solution.

Solution B: 40 gr of persulphate of ammonia dissolved in 1 litre of distilled water.

Solution C: 3.5 gr of bisulphite of sodium dissolved in 1 litre of distilled water.

To each litre of Solution A we added 10 ml of Solution B and 20 ml of Solution C (Solution ABC). Solution ABC thus prepared remained perfectly limpid a sufficiently long time, at least a half hour at 20° C; it could be divided and placed in several containers and the containers taken and put away without difficulty, before the polymerization began to take place.

Blank Tests

Solution ABC was poured into three sets of 10 flasks, numbered 1, 2 and 3. The flasks, of Pyrex glass, had a capacity of 100 ml. Into each flask we poured only 50 ml of solution so that the flasks were half filled and the solution offered the greatest possible surface towards the top. After filling, the flasks were closed with rubber stoppers.

The three sets of flasks were placed in one wooden box, which was long and narrow, in three parallel rows. The box was sealed by a wooden cover and it was left by itself in a closed room. After 12-14 hours the flasks were removed and their contents filtered. The filtering was carried out with a pump, using three identical funnels, numbered 1, 2 and 3, each receiving the contents of the corresponding set. Thus we collected the total quantity of polymer formed in each set. The polymer was dried at 110° C, until a constancy of weight was reached, then it was weighed. The quantity of monomer remaining in the liquid was checked by measurements of surface tension (4).

The weights of polymer obtained varied frequently from one day to another, but, *for one single experiment, the weights given by each set were equal or nearly equal.* The differences never surpassed 2%.

The method of operation therefore seemed to be very satisfactory.

Tests with the Electromagnetic Field

The flasks of the three sets were filled with Solution ABC as in the case of the blank tests. Then were distributed in the following fashion:

Set 1 – The flasks were placed in a cylindrical copper container, set on the ground, which could be completely sealed by a copper cover. On the inside of this container, a second, smaller, cylinder of copper was fixed coaxially, electrically isolated from the first. The flasks were placed between the two cylinders. Then the cover was put in place and an electromagnetic field was applied between the two cylinders.

The field was produced by a generator with a power of 10 W. the AF Mod. 1C: 101, of the Firm Damiani & Ciappi, Florence. This was the same generator used for studying the precipitation of oxychloride of bismuth. It was regulated on a 30 km wave length, that is to say on a frequency of 10 kHz, as in the case of the oxychloride of bismuth. The copper screen constituted a shield against the exterior fields.

Set 2 – The flasks were set in a container quite identical to that of Set 1. The position of the flasks was the same. Only, the electromagnetic field was not applied. The copper screen constituted a shield against the external field.

Set 3 – The flasks were set in a blackened cardboard container, identical in size and shape to the two previously described. The position of the flasks was again the same; no electromagnetic field, no copper enclosing the flasks. The cardboard screen did not constitute a shield against the external fields.

The tests were begun at 7 p.m. and were interrupted at 9 o'clock the following morning, for the polymerization was not to be allowed to surpass, generally, 50% of the monomer. The three containers were permanently kept in a room with the temperature carefully regulated at 21 + 0.1° C. The generator, completely screened, was also in the same room. A field indicator tuned on the 30 km wave length did not show any appreciable emission in the room while the generator was running.

We measured the temperature inside the containers and inside the flasks and found that if polymerization did not take place, the temperature inside the flasks was identical to that of the room.

If polymerization took place, the temperature in the flasks rose some tenth of a degree because of the heat given off by the polymerization.

The bisulphite sodium solution was also daily controlled by iodometry, so as to assure the constancy of its reductive power.

Experiments were made from December 1, 1959 to January 7, 1960.

Three tests out of 37 did not give any polymer, in spite of the constancy of the experimental conditions. These tests *are not be rejected* but must be considered as quite successful tests which gave a nil weight of polymer.

The 34 remaining tests gave the following results:

1) The total weights of polymer given in the three sets, in one single experiment, *differed among themselves much more than was the case in the blank tests: up to 50%!*

2) Comparing the weights of Set 1 (field and shield) with the corresponding weights of Set 2 (no field, shield), it was found that Set 1 gave a greater weight of polymer 19 times over 34. That is about 56%.

3) Comparing the weights of Set 1 (field and shield) with the corresponding weights of Set 3 (no field, no shield), it was found that Set 1 gave a greater weight of polymer 20 times over 34. That is about 59%.

4) Comparing the weights of Set 2 (no field, shield) with the corresponding weights of Set 3 (no field, no shield), it was found that Set 2 gave a greater weight of polymer 19 times over 33. That is about 57%.

We therefore observed *an effect of the electromagnetic field*, small but appreciable, and *an effect of shield*, also small but appreciable. It is evident that, being given the chemical identity of the polymerizable material and the identity of the temperature and of the other traditional variables, *the factors responsible for disturbing the polymerization were only those introduced by ourselves (electromagnetic field and shield) or those of a spacial origin.* But in this connection it is necessary to take note of an even more important fact, it seems to us:

5) The total weight of polymer collected in a set of 10 flasks varies greatly from one day to another: from 0 to 19 gr, for 30 gr of monomer introduced into the 10 flasks; that is to say, from 0 to 63% of the monomer. All of this in spite of the perfect uniformity of solutions A, B and C, which were prepared and measured anew each day.

The variation is felt *at the same time by the three sets*, which simultaneously give either very small weights, medium weights, large weights or very large weights.

Correlation with Chemical Test P

Evidently there are *natural phenomena which operate with much more force than our fields and screens.* We have therefore correlated the weights of polymer furnished by Set 3 (no field, no shield) with the results of *Test P* (5) which were registered at Florence.

The correlation is significant—or better—very good. The Rawer's correlation number, is indeed 0.28. It therefore becomes necessary to think that the observed variations are truly due to the influence of spacial phenomena.

* * *

The polymerization of acrylonitryle in an aqueous medium, which is certainly dependent on the structure of water and on variations in this structure, seems then to be influenced by:

1) a low-frequency electromagnetic field;

2) a metal shield;

3) natural phenomena, for the moment unidentified, which operate much more powerfully than an electromagnetic field of 10 kHz, and the effect is therefore not completely eliminated by a thin copper shield.

The same "forces" which act upon the polymerization of acrylonitryle are felt by a quite different chemical process: the hydrolysis of trichloride of bismuth with formation of insoluble oxychloride in a colloidal state. But under these conditions, polymerization is a rather long process, hydrolysis of trichloride of bismuth is extremely rapid.

These two processes, so different, have nothing in common save the medium in which they take place: *water*.

This is most instructive for us.

A Remark

In my exposition in this particular chapter perhaps I have gone too far into minute details prolonging the discussion, but, given the complexity and singularity of the material, there was no other recourse.

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APPENDIX

(Instructions for IGY research)

Preparation of the Bismuth Chloride Solution

Chemicals

1) Concentrated hydrochloric acid (commercial pure).
2) Bismuth carbonate (commercial).
3) Water (drinkable).

Preparation

Dilute 1:8 the acid with drinkable water, for ex. add 7 liters water to 1 liter acid. We obtain 8 liters hydrochloric acid 1.5 N. (approximately).

Dissolve 35 grms bismuth carbonate per liter acid 1.5 N. The solution is ready for use. It is necessary to ascertain if the dissolution is complete. With a greater amount of solution (50-60 liters) the dissolution process is complete after 24 hours about. It is preferable to prepare a larger amount of solution and keep it in a glass or plastic demijohn.

Recovering

Bismuth is dear. It is convenient to recover it. Assemble the contents of the beakers after the experiment, decant the clear liquid and keep the white precipitate of BiOCl.

Remark

It is not necessary that the composition of the solution be absolutely exact. It is instead *necessary* to take the solution from the same bottle for each experiment.

P-Test

Number 10 beakers from 1 to 10 with blue colour and 10 with red colour.

Pour in each numbered beaker 5 ml solution.

Take 20 beakers without number and pour 25 ml water in each.

Place the blue numbered beakers in open air and the red numbered beakers under a large plate of copper—or better in a room completely covered with copper plates.

Place 10 beakers without number (containing 25 ml water) near the blue numbered beakers and 10 near the red numbered beakers.

Pour the water simultaneously in a blue numbered beaker and in a red numbered beaker with same number.

When the sedimentation begins, take the beakers and pair the beakers with the same number, one blue and the other red.

Read how many times the precipitate is lower in the red numbered beakers and calculate the percentage of these. This percentage is the numerical answer of the chemical test P.

F-Test and D-Test

For F and D test the operation is similar, but we must fill the blue and the red numbered beakers alternatively with normal and activated water—that is, the *odd* numbered with normal and the *even* numbered with activated water.

Form the pair with an odd numbered and an even numbered beaker of the same colour.

Better than glass beakers are polystyrol tubes for pharmaceutical use. The diameter of the beakers is approximately 30 mm (internal).

For activation use a glass bulb with mercury and neon (already described in this chapter) or magnetic field.

Mechanization of Chemical Tests

For the research during the IGY a syncronous mixer (Model 20 A) was built which permits the effecting of 20 precipitations simultaneously under standard conditions.