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A. M. D. G.

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of the

American Association of Jesuit Scientists

(Eastern Section)

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EASTERN STATES DIVISION

VOL. XIII DECEMBER, 1935 No. 2

SCIENCE AND PHILOSOPHY

NATURE'S LAWS AND THE PRINCIPLE OF CAUSALITY

REV. JOSEPH P. KELLY, S.J.

I. Causality in Philosophy and in Classical Physics

It is frequently asserted that the Principle of Causality has been definitely overthrown by the development of statistical laws and the Uncertainty Principle. The statement is ambiguous and has led to much confusion. We propose to discuss in these papers the question of causality in its philosophical aspects, to consider its position in Classical Physics and finally its relation to modern science, especially with regard to statistical laws. This will, we hope, give us a clear background for a proper interpretation of the assertion that modern scientists have rejected the principle of causality.

Classical Physics was dominated by the Principle of Determinism. This was the characteristic note of the universe as conceived by men of science in the last century. They believed that the world was an immense machine-like organization, in which each part played a definite role. Every natural body was a determined individual, having its own powers and qualities; it possessed an activity proper to itself and when placed in favorable conditions, inevitably produced an effect "destined by nature". Extensive investigation both in Nature and under controlled conditions in the laboratory seemed to verify this belief.

It was observed that natural activity was spontaneous and independent of the observer. It was constant and uniform and seemingly according to some rule. By comparison with the actions of human beings, in obedience to a law, the notion of a law of nature was formed, and it was held that Nature likewise "obeyed" its laws. (1). Further research showed that these "laws" were valid within the range of experience and through them the scientist was able to predict, in given cases, the results of natural activity. Hence, these physical laws expressed two things; first, a definite relation between antecedent conditions and consequent phenomena, and secondly, an implied relation, that the consequent was in some way determined or produced by the antecedent.

One of the clearest and boldest expressions of this belief in a causally determined world was stated by Laplace. "If an intelli-

(1). c.f. "Jesuit Science Bulletin." Laws of Nature. Dec. 1933.

gence, for one given instant, recognizes all the forces which animate nature, and the respective positions of the things which compose it, and if that intelligence is also sufficiently vast to subject these data to analysis, it will comprehend in one formula, the movement of the largest body of the universe as well as those of the minutest atom; nothing will be uncertain to its vision. The human mind offers in the perfection which it is able to give to Astronomy, a modest example of such an intelligence.(2).

This is the conclusion and commentary of Laplace on the value of Newton's Law of Gravitation. Nature is determined and acts according to fixed laws. Since this principle in science is based on experience, the scientist does not intend the metaphysical implications which it contains. In its ultimate justification, it depends on the principle of natural causation, in the strict sense of the term. For the scientist, however, it is a methodological principle, a working principle which directs his investigation.(3). We must therefore, distinguish two aspects of the question: one, the metaphysical principle of causality, the basic principle of ontological determinism; and secondly, causality in relation to determination as a methodological principle.

Causality In Traditional Philosophy

We must first note that there is an essential difference between the scientific and philosophical meaning of the word, "cause". There are many terms employed in science which have had their origin in philosophy and which in the course of time have been gradually modified. The notion of cause is one example. In traditional philosophy, a cause signified that which by a physical action determines the existence of a new being.(4). The new being thus determined is called the effect. The causal action or the efficient causality consists in this, that a being, an agent, by the exercise of its energies or powers, brings into existence something which did not previously exist and which has not in itself the sufficient reason of its existence. Hence, causality deals primarily with the "coming into existence" of a being. When something begins to be, which previously did not exist, we seek a reason why it exists. The reason is found in its cause and the determination by this cause. The Principle of Causality states: "Whatever begins to be, must have an efficient cause". Material bodies are contingent beings, that is, they may or may not exist. Their nature or essence does not imply a *necessity* for existence. As the philosophers say, they are "indifferent to existence".

(2). Laplace. "Mechanique Céleste." Bk. XV. Ch. I.

(3) A methodological principle. A principle whose validity is either simply assumed or partially verified, e.g. by experience, and which is used as a directive norm in carrying out a process of investigation. Accepting the principle of determinism, the scientist proceeds with his experiments on unknown phenomena on the supposition that these will happen in the same constant and uniform manner as those which he has already investigated.

(4) In this discussion we limit the question to efficient causes.

This means that they have a deficiency, or an insufficiency for bringing themselves into existence. If they begin to be, they must depend on another for this existence. This is true not only for their initial existence but for every new state which they may acquire by change or mutation. In every modification, there is a "newness" of being; a new state, shape, location, loss or gain of qualities. Therefore, every body, under whatever formality it is new, must be referred to an antecedent as to a cause. An absolute beginning in a material body is impossible. In the adequate comprehension of a material being, the principle of causality is demanded by the human intellect. This is not a mere creation of the mind; it gives the reason for the transition from non-existence to existence.

Scholastic Philosophy makes a clear distinction between the necessary, non-free actions of material entities and the free causal actions of rational beings. Physical bodies are causes in the real sense of the term. They, by their actions, produce other physical beings. But they are determined, that is, they are limited to one mode of action, they always set in the same manner and produce the same effect. When placed in certain circumstances, the effect always follows. There is no choice of activity. Hence, says St. Thomas, there is a natural bond or nexus between a specific being and its necessary effect. From the consideration of these natural causes and the necessity with which they produced their effects, arose the dictum; "physical beings are determined necessary causes and if left to themselves will produce the same effects under the same conditions."(5). This was the ontological determinism of the philosophers. It was based on the principle of casuality applied to non-free, necessary causes. It was not a scientific discovery in the modern sense of the term but a metaphysical interpretation founded on observation and reason.

This concept of a cause, as an agent exercising an influence on the "coming into existence" of another body, was commonly accepted both in science and philosophy and was the object of investigation until the time of Galileo. Unsatisfied with the apparently small progress that was made through metaphysical speculation, he decided "to abandon the position of interpreting nature on authority and begin with experimental data." He believed that in this way he could arrive at an intimate knowledge of natural phenomena. "It does not seem to me advantageous now to examine what the cause of acceleration is"(6). There is no need to dwell on the work of Galileo and its results. They are too well known. But it is important to note that this was the beginning of a new era in science; it was the introduction of the experimental method as a definite system of interpreting the phenomena of nature. The method had been long known but

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(5). St. Thomas. "Summa Theol." Ia, q. 19; art. 3. "Contra Gent." Bk. II. c. 30.
(6). Galileo. "Discoursi."

little use had been made of it.(7). Galileo's own view of the subject was that "some superficial observations have been made, as for instance, that the free motion of a heavy body falling, is continuously accelerated. For as far as I know, no one has yet pointed out that the distances traversed during equal intervals of time, by a body falling from rest, stand to each other in the same ratio as the odd numbers beginning from unity . . . but this and other facts, not few in number or less worth knowing, I have succeeded in proving; and what I consider more important, there have been opened up to this vast and excellent science, of which my word was merely a beginning, ways and means by which other minds more acute than mine will explore its remote corners".(8).

The point that pertains to the present question is that Galileo himself supposed the notion of causality in the traditional sense of the term. In his experimental work he had no intention of denying the validity of the principle of causality. No more did Newton when he said that "it is sufficient that gravitation exists, that it acts according to the laws which we have formulated and that it explains the motions of the heavenly bodies and the seas".(9). If we consider the work of Galileo and Newton, we shall see, I believe, that the following explanation is quite valid. Accepting the fact that there was a real causality in the "force of gravity", that the motions of certain material bodies were *caused* by this, they first tried to express the effects of these motions in quantitative terms, e.g., the velocity and distance through which the body moved. Then they proceeded to look for a mathematical formula which would describe, in numerical quantities, the causal relation for all such cases. Hence, not only did they suppose a real relation between cause and effect but through this formula they could show in definite cases, the exact or approximate numerical value of this causal relation. This is the origin of the law of nature in science. It follows that since there is an invariable sequence between antecedent and consequent, if the antecedent factors are quantitatively known, the consequent result can be predicted with accuracy. We shall see more of this predictability later.

A Changing Philosophy Of Causality

Galileo prophesied that the experimental method would open vast avenues of investigation for science. The scientific genius of men like Tycho Brahe, Kepler and Newton produced a picture of the universe in which the actions of bodies, the laws of nature and the order of the world expressed in mathematical terms. The accurate results obtained from this method and the intimate knowledge of nature's phenomena obscured the philosophical concepts of the universe. The

(7) Aristotle. "Post Anal." II. 19.—Scotus. "In. I. Sent." Dist. III. q. IV, 9. c.f. St. Thos. "Com. in Aristotelem." Suarez. "Meta Disp." I. Sec. VI.

(8). Galileo. "Two New Branches of Science" Ed. Crewe and De Salvio.

(9). Newton. "Principia." Bk. III. System of the World. General Scholium.

change in scientific thought naturally reacted on philosophy. In the Empiristic School of philosophers, Locke, Hume and Mills started on the principle that experience was the only safe guide to knowledge. Beyond this there was no valid knowledge. Hume declared that the notion of cause could never be derived from experience. In Physics, phenomena are considered to be causally connected when they invariably succeed each other in time. The succession of events is all that can be perceived; we cannot observe an inner necessity binding them together.(10). This presented a serious problem. Hume admitted that in all reasoning on matters of fact, the relation of cause and effect was fundamental but that it could not be derived from the objective facts themselves. How can we explain rationally the persistence of this notion? "Our idea therefore, of causality and necessity arises entirely from the uniformity observable in the operations of nature, where similar objects are constantly conjoined together and the mind is determined by custom to infer one from the appearance of the other.(11). Causality then, is not a perfection of a power by which one thing produces another, it is a creation of the mind by habit or custom. This introduces a new meaning into the concept of a cause. It is no longer an agent exercising a productive influence on another. Neither Hume nor the other philosophers of this school succeeded in giving a rational explanation for that which all men perceived and which was an accepted principle of science, viz: that from the same antecedents, the same consequents follow, with a natural necessity. For there are other sequences in events which are not thus connected, e.g. night follows day but no one would say that the day is the *cause* of the night. In the invariable sequence of natural phenomena there is something more than a mere succession. There is the dependence of the consequent on the antecedent; there is a determining factor which produced the consequent event. For Hume and his followers there was but one course left, to substitute for the idea of cause, the notion of invariable sequence. This is certainly foreign to the Newtonian concept that: "we are to admit no more *causes* of natural things than such as are both true and sufficient to explain their appearances. Wherefore, to the same natural effects, we must, as far as possible, assign the same natural *causes*". In the science and philosophy of Newton and other early scientists, cause was as objective and real as the physical being itself.

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(10) The Scholastics did not believe that the perception of a casual nexus between phenomena was a sense perception. The intellect perceives this relation. Between these events there is a relation of dependence. The data of the senses tell us of the succession of events; the intellect, on the principle of sufficient reason, gives us the relation of causality.
We take the English philosophers as representative of the change in philosophic thought on the question of causality.

(11). Hume. "Enquiry Concerning the Human Understanding." Sect. VIII, pt. I.

Also. "Having found in many instances that any two objects, heat and flame, snow and cold have always been conjoined together, if flame and snow are presented anew to the senses, the mind is carried by custom to expect heat and cold and to believe that such a quality does exist and will discover itself on a near approach." Idem. Sect. V. pt. I.

The New Attitude of Science

In spite of these philosophical discussions of causality, the scientists continued to progress. A successful investigation of nature was to be found through the experimental method and the guiding principle was Physical Determinism. In science this was a methodological principle. It was founded on the invariable sequence of phenomena and in the constancy and uniformity which the scientist observed in the activity of nature. Whether or not this was dependent on the metaphysical principle of causality, the scientist did not inquire. He was content that experience justified him in the use of the principle and that he was able to generalize his experience and formulate his laws of nature according to which physical beings acted. But it was more than a means of generalizing past experience; it was a "working principle" for future research. This postulate of physical determinism was very necessary for science. Without it, there could be no summarizing of experience, no laws of nature in the scientific sense of the term. If it is rejected, it closes a wide field of investigation and raises an almost impassable barrier for research. Unless the scientist has some guarantee that natural activity will follow definite modes of action, that his experiments will proceed according to some rule, scientific progress becomes haphazard, a "hit or miss" sort of trial. The guarantee is found in the postulate of determinism. By means of this principle he can calculate in advance the results of his work and foresee a definite method of procedure. Physical determinism is a pragmatic principle; "it works", it enables to experiment or to obtain results. It has a pragmatic sanction.

An important consequence of this principle has been a notable emphasis on the predictability of events. Since nature is determined in its activity and there is an invariable sequence of phenomena, it follows necessarily, as Laplace stated, that if we know sufficiently the antecedent factors, we can predict the consequent results. Science has adopted this course. This process introduced a practical identity between predictability and causality. An event is predictable in the scientific sense, if the antecedent factors and their relationship are sufficiently known. If the scientist can express these in quantitative terms, he can, on the principle of determinism, foretell what quantitative results will follow. Planck tells us "By a causal link between two successive events, we mean a causal connection, subject to law, between two events of which the earlier is called the cause and the later the effect . . . . an event is *causally conditioned if it can be predicted with accuracy*".(12). Here is a practical identity between causality and predictability. Although he continues and makes a distinction which is of great importance, nevertheless, he makes predictability the criterion for the affirmation or the denial of causality. "Thereby, I wish only to say that the *possibility of making a correct*

(12). Planck. "Causality in Science." cf. "Science for a New World." Crother. p.347.

prediction of a future event forms an infallible criterion for the existence of a causal connection, not by any means one and the same thing".(13). It is indeed one thing to assert that two events are causally connected. It is quite another matter to know the mathematical value of the antecedent so that the effects can be predicted. If an event comes into existence it must be caused. There is a causal connection between cause and effect independent of predictability. Neither science nor philosophy would assert that any event is uncaused. The scientist limits his scope to causality of predictable events; in this he is fully justified in view of the aims of his science. But there can be no justification in denying the causal connection in those cases when it is evident from other principles. We see here, how far the notion of causality has been changed from the traditional concept and how necessary it is to understand the precise meaning of the term in the various branches of knowledge. The inability to predict a result by no means warrants the denial of causality unless we admit that predictability and causality are indentified. In traditional philosophy, causality has a "post-factum" aspect. A being has come into existence; we seek a reason for it. It is found in an anterior reality which determines, produces or causes it. Science on the other hand takes an "ante-factum" and previsional view. It wishes to be able to predict what will follow from a given antecedent. It does not ask, "what is the cause" but what will be the result. This supposes that the antecedent will act as a cause and produce the result according to the predictions of the scientist. The two points of view are distinct. Predictability, presupposing a causal connection, may be used as a criterion for affirming causality but the impossibility to fortell an event cannot be a logical criterion for the denial of causality.

In this discussion we have seen the philosophical concept of causality which deals with the coming into existence of a being. In the development of science and the modification of philosophic thought there has been a change in the meaning of causality. We can freely admit that the scientist may, if he chooses, define a cause as the antecedent or group of conditions from which an effect always follows, and may introduce any other modifications which the purpose of the physical sciences dictates. The affirmation or denial of this new concept will not affect the traditional meaning of the term. Whatever may be said of this modern concept of cause, it must be interpreted in the light of the principles which determine it and as not affecting the philosophical notion, which remains intact, despite all these changes. Until about the middle of the last century, the strict validity of cause was accepted and deemed necessary as a fundamental principle of science. It was the basis of the laws of nature and of the principle of the uniformity of nature. As Huxley said,

(13). idem.

the act of faith necessary for science was the acceptance of the universality of order and the absolute validity of the law of causation. In our next article we shall see the changes that have come into the concept of a law of nature and the steps that have led to the denial of causality.

Editor's Note. This is the first of a series of four articles dealing with the problem of causality in relation to physical science. The discussion will be carried on from a philosophical and scientific point of view. The current volume of the "BULLETIN" will contain the following papers:

December 1935. Causality in Philosophy and Classical Physics. Rev. J. P. Kelly, S.J.

March 1936. Statistical Laws From the Physical View-point. Rev. T. H. Quigley, S.J.

March 1936. The Principle of Causality and Statistical Laws. Rev. J. P. Kelly, S.J.

May 1936. The Uncertainty Principle. Rev. T. H. Quigley, S.J.

ASTRONOMY

THE O'LEARY FREE-PENDULUM CLOCK

(The invention of Rev. William O'Leary, S.J., St. Ignatius College Observatory, Riverview, Sydney, Australia.)

Rev. Paul A. McNally, S.J.

The ideal or theoretically perfect clock is an instrument that measures the passage of time—and in this measuring is entirely free from variations of any kind whatsoever.

Of course, such a theoretically perfect clock is an impossibility. Both the internal and external elements of a clock are of necessity variables. Our best efforts, therefore, in setting up time-keepers can only be approximations to the ideal. The history of progress in this field—from the early water and sand clocks, to our present vibrating crystals—is most interesting.

The variables that are external to the clock may be, briefly, listed under the heads of temperature, pressure and location.

Temperature and pressure can be controlled with a very high degree of accuracy.

Location—and this takes in the matter of gravity—while the variations that fall under this head may not be controlled, they may be determined and allowed for in the final reading of the clock.

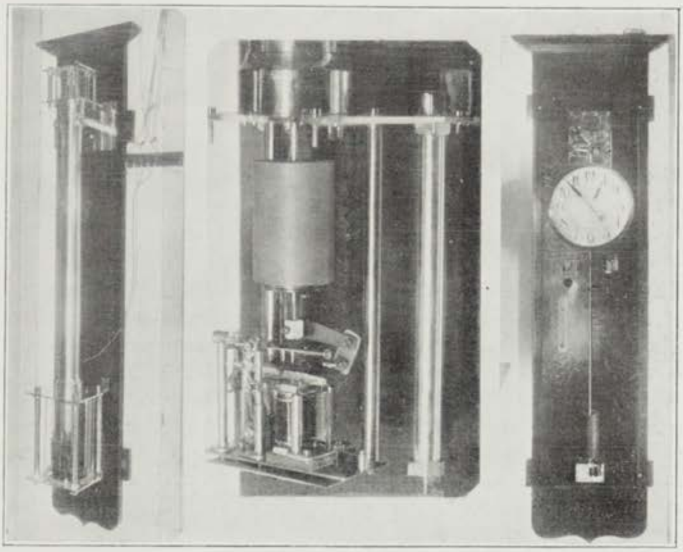
The variations that are internal to the clock arise from the parts of the clock—the material used—the size— and the shape. Whence arise wear, friction and change of form.

Before the appearance of the first Shortt free-pendulum clock in 1922, much progress had been made in controlling or determining the variations present in a given clock. The Reifler clock was considered to be as near perfection as could be hoped for.

It is rather surprising that no one thought, sooner, of a very simple solution of the difficulty connected with the variations arising from the many parts in a clock—Mr. Shortt's simple solution was—get rid of the parts—at least, those that are not essential. In a pendulum clock the only essential part is the swinging pendulum.

With all the wheels gone and only a pendulum that is to swing uniformly remaining there are still sources of variation to be dealt with. The stuff of which the pendulum is made, and the impulse that caused the pendulum to swing. In both the Shortt and the O'Leary clocks the pendulum is made of invar, an extremely rigid variety of steel. In both cases also the impulse is imparted by a free-falling armature. This armature is small and its falls are controlled by another clock, called the slave clock.

Here very briefly you have the particulars of the free-pendulum clock. The pictures will show the details better than many words.



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First picture shows the free pendulum in its case. It is under reduced pressure and controlled temperature.

A very interesting fact in connection with pressure was discovered in the experimentations with the Shortt blocks at Greenwich—"Obviously a reduction in pressure, in itself a cause of acceleration, will result in an increase of arc, which by circular error, retards. These opposite effects are found to compensate one another exactly at a pressure of .74" of mercury."

Second picture shows the bottom of the free pendulum in detail. The small armature, with a wheel at the end, gives the impulse by a free fall of a fraction of an inch. The impulse is received on the small ledge as the pendulum swings away. The magnets below are actuated from a connection at the slave-clock, and draw away the support that hold the armature in place.

Third picture shows the slave clock.

At the left, below the face, is a small mechanism controlling the impulses for the slave-clock pendulum. As the pendulum begins to lose amplitude a small armature is lifted making an electric contact which actuates one set of magnets at the bottom—these impart a gentle impulse to the pendulum.

On the right, below the face, is the correcting mechanism. If the armature giving the impulse to the free-pendulum falls too soon i. e. if the slave-clock is going faster than the free-pendulum clock then an electric contact is made at this point, and one set of the magnets at the bottom is actuated, retarding the slave-clock pendulum. If the error is in the other direction, the other set of magnets is actuated and a slight push is given to the slave-clock pendulum.

The impulses are given to the free-pendulum every half minute—and the armature, after it falls from the ledge where the impulse is given to the free-pendulum, makes a contact which regulates the correcting mechanism on the slave-clock. This seems rather involved, but in reality is quite simple.

The most important improvement in the O'Leary clock over the Shortt clock is the introduction of a corrector that works in both directions. With the Shortt clock the slave is always made to run slow—and so is always corrected with a push. The O'Leary clock is adjusted to keep perfect time with the free-pendulum—and can be corrected in either direction when slight irregularities occur.

In most places, time is read from the slave clock, which can never be very wrong. Here at Georgetown, it is proposed to run a secondary clock directly from the free-pendulum by means of a photo-electric cell.

Clocks with wheels, of a high degree of accuracy, held their place for a long time before the introduction of the free-pendulum clocks. The reign of the free-pendulum clocks, however, will not be so long, if the vibrating crystal clocks continue to show the extremely high degree of accuracy that have already been obtained with them.

BIOLOGY

BLOOD-GROUPS AND TRANSFUSION

Rev. Clarence E. Shaffrey, S.J.

The desire to supply a patient with blood after a profuse hemorrhage, or in cases of severe anaemia from one cause or another led to the attempt to furnish relief by transfusion of blood from one healthy individual into the vessels of the ailing one.

The first blood-transfusion recorded was in 1667 by Jean Baptiste Denys. The practice was not long continued because the operation was very seldom successful. Later is was forbidden by law. Little interest was taken in the subject until 1900 when Landsteiner and Shattock working independently found that the serum of certain bloods would agglutinate or clump the cells of certain other bloods. Landois in 1874 showed that some normal sera have the property of clumping or agglutinating the red corpuscles of animals belonging to a different species, but the possibility of the same thing happening with a serum and corpuscles belonging to an animal of the same species was not recognized until the work of Shattock and Landsteiner. However, according to Furuhata, a Japanese serologist, the fact of iso-agglutination would seem to have been known long ago in China, since the utility for medica-legal cases of mixing the blood of both parties to a paternity suit is mentioned in a four-volume treatise entitled Sen-en-raku, dated 1247.

Shattock published his observations in which he stated that the serum of persons suffering from certain diseases has the power of agglutinating the corpuscles of healthly persons. He believed that iso-agglutination was caused by some pathological condition of the blood of sick persons; others thought that only a small proportion of healthy individuals possessed the agglutinating substance; others believed that the property varied widely in the same individual. At present the idea that iso-agglutination is definitely related to disease is abandoned.

When transfusion was resorted to it was found that in some cases all went well, while in very many cases clumping took place and often with fatal result.

The reason for the difference in response to transfusion was not understood until Landsteiner of the Rockfeller Institute pointed out that this clumping of the corpuscles by the blood of another of the same species, that is, the power of agglutination, is regularly found in normal sera, and too that these same agglutinins can pass to the milk or colostrum, the cerebro-spinal fluid, the saliva, and also to transudates and exudates, a pleural, pericardial and peritoneal fluids, etc.

It has since been shown that the iso-agglutinating properties of normal blood are not the same in all individuals but that the blood could be divided into three groups. This was shown by Landsteiner in 1901. He called the groups A, B, and C. The serum of group A agglutinated the corpuscles of another group, B, but not those of group A. The serum of C agglutinated the corpuscles of both A and B but not those of C.

But the classification of Landsteiner was found to be incomplete, and in 1902 another group was found. In this group the serum does not agglutinate any of the corpuscles of the other groups, but the corpuscles of this group are agglutinated by the sera of all the other groups. Jansky and Moss working independently showed exceptions to Landsteiner's original classification, and these they regarded as due to a fourth group which had escaped notice because of its infrequent occurrence.

In what precisely does the phenomenon of agglutination consist? To what is it due? The theoretical explanation of the blood-groups is that there are in the serum certain substances, now called agglutinins, which react with corresponding substances, now called agglutinogens, which are contained in the red copuscles and cause agglutination or clumping.

By elective absorption experiments Landsteiner showed the above to be true. There are two agglutinogens, and they are designated A and B, and there are two agglutinins, a and b. The agglutinin a will react with agglutinogen A and cause clumping, and agglutinin b will react with agglutinogen B with a like result.

Every individual has in his blood either or neither or both agglutinogens, A and B, and either or neither or both agglutinins a and b. But in nomal blood an agglutinogen and its agglutinin are never found together; if they were both present the blood would agglutinate and would not flow.

The state of belonging to a definite blood-group is a fixed character of every human being and can be altered neither by the lapse of time nor by intermittent disease, nor does it change after death.

According to Jansky's classification we have the following:

Groups	I	II	III	IV
Corpuscles (agglutinogens)	O	A	B	AB
Serum (agglutinins)	ab	b	a	o

Moss in renumbering the groups reversed the places of Jansky's first and fourth groups, giving the following classifications:

Groups	I	II	III	IV
Corpuscles (agglutinogens)	AB	A	B	O
Serum (agglutinins)				

The following table shows the groups as classified by Jansky and Moss and also the universal classification. The last classification has supplanted Moss' classification which was in more general use in America. Landsteiner in 1925 suggested that the blood groups be designated according to the isoagglutinogen content of the red cells, i.e., O, B, B, AB. This classification has been universally adopted upon the recommendation of the Commission for the Standardization of Sera of the Public Health Committee of the League of Nations.

Landsteiner's Oringinal	Jansky	Moss	Universal
C	I	IV	O
A	II	II	A
B	III	III	B
—	IV	I	AB

Agglutinogens and Agglutinins of the Different Groups

Group	Agglutinogen	Agglutinins
O	O	ab
A	A	b
B	B	a
AB	AB	o

Remembering that the donor's serum need not be considered in transfusion because it is so diluted by the recipient's serum that its reaction is negligible.

The following table shows the reaction between the blood of the donor and that of the receipient:

Recipient \ Donor	O ab	A b	B a	AB o
O ab	O ab ╲ A ab —	A b ╲ O ab +	B a ╲ O ab +	AB o ╲ O ab +
A b	O ab ╲ A b —	A b ╲ A b —	B a ╲ A b +	AB o ╲ A b +
B a	A ab ╲ B a —	A b ╲ B a +	B a ╲ B a —	AB o ╲ B a +
ABo	A ab ╲ AB o —	A b ╲ AB o —	B a ╲ AB o —	AB o ╲ AB o —

In this table the plus sign indicates clumping and hence incompatibility. The minus sign indicates the reverse.

Hence from the above we may deduce some general principles:

1. Those of group O are universal donors because they have no agglutinogens, i.e. corpuscular elements.
2. Groups A and B can receive corpuscles from group O and from their own group.
3. The cells of group A will be agglutinated by the serum of group B only.
4. The cells of group AB will be aggluinated by the serum of groups A and B.
5. The cells of group O will not be agglutinated by any serum because they contain no agglutinins.
6. Those of group AB are universal receipients because they have no agglutinins.

Hence: Group O. Composed of people whose red blood-cells are not agglutinated by anyone's serum, and whose serum agglutinates the red cells of persons belonging to groups A, B, and AB.

Group A. Composed of people whose red cells are agglutinated by sera of group O and group B, but not by groups A and AB, and whose serum agglutinates the red cells of persons belonging to groups B and AB.

Group B. Composed of people whose red cells are agglutinated by sera of groups O and A and not B and AB, and whose serum agglutinates the red cells of groups A and AB.

Group AB. Composed of people whose red cells are agglutinated by all sera except their own, and whose serum does not agglutinate any red cells.

From the above we see that the members of Group O are universal donors, and those of Group AB are universal recipients.

Hence to summarize: Given a sample of blood to be tested, and given stock sera of groups A and B. Test with serum A and with serum B, and if clumping follows in both cases it is group AB. If only group A serum causes clumping it is group B; if only group B serum causes clumping it is group A, and if neither serum A or B causes clumping it is group O.

In the typing of blood there are many sources of error, and one needs to be quite familiar with the tests to interpret what happens under the scope, and be able to distinguish between true and false agglutination and to recognize the presence of what are called subgroups, i.e. groups within a group, such as A_1 and A_2 within group A.

One kind of pseudo-agglutination is rouleau formation, which is a phenomenon occurring in normal individuals but only to a minor degree. This formation is characterized by a piling up of the cells, resembling piles of coins. This phenomenon is more marked in conditions associated with rapid sedimentation time. In pregnancy and severe anaemias rouleau formation may be so pronounced that the clumps become so irregular as superficially to resemble the clumping caused by true agglutination. Such pronounced rouleau formation is known as pseudo-agglutination.

Pseudo-agglutination may be readily recognized by examination of the specimen under the high power of the microscope. In rouleau formation the individual corpuscles can be distinguished, while in true agglutination they cannot. And, too, rouleau formation disappears on slight dilution. The simplest way to prevent pseudo-agglutination is to dilute the suspensions of the patient's blood from 1 to 5 per cent. The reason for this is the fact that the active principle responsible for rouleau formation or rather the extreme form, pseudo-agglutination, is in the serum. Hence the most certain way of preventing pseudo-agglutination is to wash the cells, thus entirely removing the troublesome serum.

Serologists have long been interested in a rather rare phenomenon known as auto-agglutination, which is a clumping of the erythrocytes into irregular massess visible to the naked eye, in the presence of the individual's own serum, without bacterial action, at air temperature and reversible at body temperature. Landsteiner, Clough, Richter, Li Chen-Pien and other investigators have shown that auto-agglutinins are present in the blood serum and are dependent on a lower-than-body-temperature. They are absorbed from the serum at low temperature and become fixed in the red cells. The auto-agglutinins can be freed from the red cells by washing and suspending in warm saline solution, in which solution they can be demonstrated. Lattes observes that in spite of the fact saline will wash out some of these agglutinins from the red blood corpuscles, it is very difficult to remove it all from the erythrocytes, they being demonstrable after thirty washings. The washings must be done at body temperature and in physiological salt solution (0.85%).

Sensitization may cause cross-agglutination within the same blood group. One tranfusion of blood from a given donor may occasionally sensitize the patient to this blood, as demonstrated by the clumping of the donor's red cells by the serum of the recipient.

Another source of cross-agglutination, i.e., the agglutination of the red cells of a group by serum of the same group, is the presence of sub-groups in a group. This could be true of any group, but is certainly known to be true of the group A. Binlov found that the factor A does not represent a definitely separate group but that it may exist in variants designated by A_1 and A_2. As a result each of the sub-groups A and AB is divided into two sub-groups, A_1 and A_2, and A_1B and A_2B. These groups are recognized qualitatively through definite serologic characteristics. The difference in properties of these sub-groups explains the so-called exceptions in the classic four group scheme and the transitions of one group into another as described by various authors. Binlov found A_1 to be three times as frequent as A_2, while A_1B is about as frequent as A_2B. A_1 and A_2 are hereditary characteristics. They are transmitted to the offspring according to Mendelian laws, A_1 being dominant and A_2 the recessive factor. This we shall see may be of considerable importance in medico-legal questions.

Application of Hemolysis and Agglutination to Blood Transfusion Tests.—Before transfusion is resorted to the blood of the recipient must be matched with that of the donor, that is, it must be determined that neither of the bloods causes hemolysis or agglutination in the other.

If there is no reason for hurrying, the following method may be employed: Blood is obtained from both; 2 c.c. of each being sufficient. A part of each blood is received into a test tube containing about 10 c.c. of normal, or rather physiological salt solution, (0.85%), or 2% sodium citrate solution, and another part of each is allowed to clot in a small test tube. The clotted portions of the blood are stirred with a wire and put into an ice box and left until the serum separates from the clot. The portions received into the salt solution are washed three times. This is done by first centrifugalizing the tubes for two or three minutes when the cells will be found packed at the bottom of the tube; then pour off the supernatant fluid, and after pouring on more salt solution or citrate solution as the case may be, centrifugalize again; after a third washing enough salt solution is added to make the cells a 10% solution.

The actual test is carried out as follows: Six Wassermann test tubes, 100x15 mm., are placed in a test tube rack, and to each one is added 1 c.c. of physiological salt solution.

The first tube receives 0.1 c.c. of recipient's cell emulsion and 0.2 c.c. of the donor's serum.

The second tube receives 0.1 c.c. of the donor's cell emulsion and 0.2 c.c. of the recipient's serum.

The above tubes are for the actual test; the following four tubes are the controls:

The third tube receives 0.1 c.c. of the recipient's cell-emulsion and 2 c.c. of the recipient's serum.

The fourth tube receives 0.1 c.c. of the donor's cell emulsion and 2 c.c. of the donor's serum.

The fifth tube receives only 0.1 c.c. of the recipient's cell-emulsion.

The sixth tube receives only 0.1 c.c. of the donor's cell-emulsion. The tubes are now incubated for thirty minutes. At the end of this time they are taken out, shaken thoroughly, and reincubated for thirty minutes longer, and examined again. The last four tubes, the control tubes, will show neither hemolysis or agglutination on shaking. It neither tube 1 or tube 2 shows hemolysis or agglutination, the blood of the donor is suitable for transfusion; if either tube 1 or tube 2 shows hemolysis, i.e., disappearance of the red cells and the contents of the tube assuming clear golden or Burgundy color, or agglutination, as shown by cell-clumps not disappearing on vigorous shaking, the donor's blood is not suitable for transfusion.

When transfusion must be done at once, and every hour counts, then a very rapid method of blood matching may be employed. In such a case the tests should be made on a slide and clumping watched under the microscope. This can be done as described above, determining the group by using the sera of Groups A and B.

A more rapid method it to match the two bloods directly on a slide as follows: Take a drop of the donor's blood in 1 c.c. of a 1.5% solution of sodium citrate to prevent coagulation. Mix one drop of the donor's corpuscles just obtained, with one drop of the recipient's serum on a slide. Examine after a few minutes. It the red cells clump, the bloods are incompatible.

The rule to be followed is: The donor's blood should not be used when there is agglutination in the mixture of the recipient's serum and the donor's corpuscles. It is best to have the donor and the recipient of the same group; that is, that the blood of one who belongs to group O may be used for transfusing persons of all the groups, severe reactions have followed its use. Hence: Always make group and compatibility tests, and have the donor and recipient of the same group.

A PROBLEM IN NEURO-ENDOCRINOLOGY

Joseph G. Keegan, S. J.

Claude Bernard's famous dictum (1) would seem to apply par excellence to the intricate nervous functions that control bodily coordination. Among the various factors that contribute to the maintenance of a *steady state* we must include the products of the endocrine glands and of these latter the Pituitary Gland or Hypophysis cerebri assumes an importance that is out of all proportion to its physical size.

It is not the intention of the writer to discuss the role of the pituitary gland in all of its aspects. Suffice it to say of the pars anterior or anterior lobe that its regulatory function in the processes of body growth and in the development of the reproductive apparatus together with its known influence over other endocrine activities—an influence that thus becomes far-reaching in the body's economy—has merited for it the title, *Master* or *Moderator Gland.*

There are, however, several considerations which may yet yield equally important conclusions concerning the function of the pars

(1) La fixité du milieu intérieur est la condition de la vie libre.

posterior and vindicate to it a role that is correspondingly basic in the regulation of the body's vegetative functions. The crux of this vindication will lie in the demonstration of the nature of the functional relationship that may exist between the posterior lobes of the hypophysis and the fundamentally important brain centers of the *hypothalamus*.

To estimate properly such a physiological relationship, it seems expedient to premise in outline the anatomical and embryological relationships of hypophysis and hypothalamus. The hypothalamus, which is associated with the so-called basal ganglia of the brain as part of the extra-pyramidal system is presently regarded as one of the chief *head centers* for the sympathetic nervous system. Consequently to influence its activity is tantamount to exerting an influence over the emotional and visceral reactions. It is located on the ventral aspect of the brain, in part directly beneath the thalamus, and including about a dozen gray masses, its nuclei are grouped into three classes: the supra-optic and tuber nuclei which lie in the floor and interior wall of the *third ventricle* and the para-ventricular nuclei, which connect, as some investigators claim, via tecto-bulbar and tecto-spinal tracts, with columns of gray matter that contain neurons of preganglionic sympathetic fibers. This would furnish the anatomical basis for experimental observations that stimulation of this region induces changes of heart-rate, blood-pressure, metabolism, temperature regulation and other vegetative functions.

But what is the foundation for a pituitary-hypothalamic interrelationship? There is certainly a basis for such relationship in an analysis of the origin and development of the pituitary gland. There is in addition presumptive evidence of a strictly anatomical connection.

From the developmental standpoint, as early as 1838 Rathke showed the dual origin of the pituitary from the buccal cavity (nasopharynx) and the hypothalamus. The formed gland loses its buccal connection but coming to lie protected in a recess of the sphenoid bone retains its hypothalamic connection through the stalk or infundibulum. As a matter of fact, the pars posterior, in which our interest is here centered is frequently termed the *neuro*-hypophysis. In addition to the neuroglia cells in it and in the infundibulum recent investigators has disclosed non-medullated nerve fibers which lie in the posterior hypophysis and connect through the stalk with the supra-optic and para-ventricular nuclei. Thus is established a nervous connection whose exact significance has not yet been clarified.

Let us now consider the possible hormonal connection. As the name neuro-hypophysis or pars nervosa might seem to imply, this portion of the pituitary gland is not very vascular. It is this fact which weakens the supposition that the active principles of the posterior lobes are secreted into the blood stream.

However, a glandular character is contributed to the posterior lobes by their epithelial investment layers, the cells of which seem to migrate into the pars nervosa and aggregate in hyaline masses. (1) This epithelial investment is formed anteriorly by the pars intermedia and around the stalk by the sleeve-like pars tuberalis. The pars tuberalis has a rich vascular supply and in histological structure resembles the anterior lobe except that it lacks eosinophilic cells. But the point to be stressed is that the posterior lobes thus become glandular in character; at least we may say that the generally favored opinion concerning the origin of physiologically active principles of the posterior lobes is thus presented.

The reader will of course be aware that a neuro-hormonal mechanism can be determined in all of its details only after long and tedious research. What is now to be said is not posited by way of a conclusion but as a suggestion along the lines of a present trend in investigation. To realize the shortcomings of any definitive pronouncement, the reader need only recall that endocrinologists are divided as to whether the physiological reaction following injection of posterior lobe extract are to be explained in the assumption of a unitary or multiple harmone.(2).

We need only mention the more notable physiological effects that follow intravenous administration. They are: a) marked elevation of arterial pressure, b) heightening of uterine contraction (oxytocic effect), c) increased intestinal tonus and motility, d) diuretic action with small dosage, and e) increased metabolic rate and temporary hyperglycemia.(3).

Nevertheless it must be observed that the undoubted physiological effects of injected extracts are not clearly demonstrated by experimental evidence to be the specific regulatory control exerted by the secretions of the posterior lobes. From the results of experimental extirpations and clinical observation varying constellations of symptons have led investigators to assign to the posterior lobes a role now in carbo-hydrate metabolism, now in temperature regulation and again in the control of water balance. The fact that all or any of these may involve so many other bodily mechanisms is in itself a difficulty. But when we add to this the fact, that the presence of the posterior pituitary principle has yet to be demonstrated in the blood stream or in the cerebro-spinal fluid, the reader is free to conclude that what is built on so tenuous a substratum must be viewed with a critical spirit.

However, I merely undertake to indicate a trend in present-day research. That the secretion of the posterior lobes is taken up by

(1) A fact which gives to this part of the pituitary a histological appearance similar to that of the thyroid.

(2) Abel and his associates have favored the unitary theory; German and English investigators more usually favor the multiple hormone theory.

(3) In many amphibians posterior lobe extract produces a distinct melanophore reaction and this is frequently used as a basis to estimate the potency of the extract.

the blood is held by some observers. But others, who are in the majority, maintain that the secretion passes through lymph channels in the infundibulum and is thus conveyed into the third ventricle, whence it may be absorbed from the cerebro-spinal fluid. Indications are at hand, but no conclusive proof of such passage into the cerebro-spinal fluid. Yet this difficulty is not insurmountable if we recall a point that has already been stressed, namely the intimate pituitary-hypothalamic interrelationship.

The posterior pituitary hormone, to be effective, need only arrive to the region of the hypothalamus in sufficient concentration to stimulate its sympathetic centers and thus exert via these same centers a control over the body's vegetative functions. Among others Asher and Cushing have supported such a view and Dr. Cushing adduced favorable experimental evidence when he reported sweating, flushing, vomiting and decreased temperature following intraventricular injection of pituitary extract, whereas such effects in subjects with destructive lesions of the hypothalamic centers.

Once again we must say that the evidence is not conclusive in view of the maze of physiological possibilities, but the view becomes extremely interesting not only when we consider its implications but especially when we recall the brilliant work of Prof. Cannon and his associates in the formulation of his *Emergency Function* Theory to explain the action of the adrenal medulla. He was face to face with a seeming enigma that in some of its ramifications resembles the problem that faces those working on the function of the posterior lobes of the pituitary.

Cannon too had to explain the working of a neuro-hormonal mechanism. The keystone in his theory is that emotional and effective changes in the body's vegetative functions—visceral reactions, increased cardiac contraction, redistribution of blood, increased respiration, hyperglycemia and reduced coagulation time—which have all the characteristics of *unconditioned* reflexes, result indirectly from an increased epinephrine secretion. Of necessity such a theory must assign a major role to a co-ordination of hypothalamic functions. The wide acceptance of this theory should, no doubt, give plausibility to the view which would involve hypothalamic centers in any complete estimate of the physiological significance of the *neuro*-hypophysis.

CHEMISTRY

MICRO DETERMINATION OF CHLORINE AND BROMINE IN ORGANIC COMPOUNDS

Rev. Richard B. Schmitt, S.J.

In *The Bulletin*, Vol. XII—No. 1, we outlined the Pregl method for the determination of halogens in organic substances. We also described the improved Parr Bomb method according to Elek, and showed that this method was accurate and more rapid than the Pregl method. By experience, we found that great care must be exercised in determining the corrections for halogen-free reagents; particularly the sodium peroxide, which cannot be obtained chemically pure. Furthermore, the Parr Bomb method includes the transfer of the fused mass to a large test-tube, and also includes the careful micro technique of filtration, drying the precipitate, etc. This method, no doubt, is an improvement on the combustion method of Pregl.

During July and August, we have tried a new method in which there is no combustion, no transfer of precipitate, and no filtration; it is the Zacherl—Krainick method, of the Medico-Chemical Research Institute, University of Graz, Austria.[1]

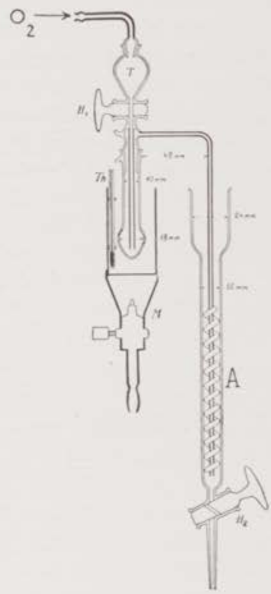
Baubigny and Chavanne[2] discovered a method of oxidation with concentrated sulphuric acid in the presence of potassium dichromate and silver nitrate, by which the chlorine and bromine in organic substances are set free and absorbed by an alkaline solution, or weighed as a precipitate.—Dieterle[3] applied this principle to a micro method and succeeded in this technique.—The procedure of Nomura and Murai[4] was also a mixture of sulphuric acid and potassium dichromate and silver nitrate for the oxidation of the organic material before the determination of the halide. This method included precipitation and filtration by the gravimetric method.

Vieböck and Zacherl (1932) discovered a means of absorbing the halogen in a 3% hydrogen peroxide alkaline solution, and by back titration measure the halogen present. The oxidation is brought about by the use of concentrated sulphuric acid with potassium dichromate and *silver* dichromate.

(1) Mikrochemie, Volume XI
(2) C. Acad. Sciences, 136-497, 1903
(3) Arch. Pharm. 259-73, 1921
(4) Bull. Soc. chim. France IV-35, 217, 1924

When these substances are heated to 115-125° C, the chlorine and bromine are quantitatively given off and escape with the excess of oxygen, and probably some ozone, carbonic acid and carbon monoxide. The gases pass over into the absorption solution of 0.01 N sodium hydroxide and 1 cc of perhydrole. The halogens form the halides and the carbonic acid is changed to a carbonate; otherwise no other acid or basic substance passes over into the absorption solution.

Description of Apparatus.—Fig. 1 is an exact drawing of the pyrex apparatus; total height is only 45 cm. The tube above the dropping funnel is attached by rubber tubing to the oxygen tank. T is a dropping funnel, in which is placed the concentrated sulphuric



acid. The end of the funnel is about 3 mm from the bottom of the oxidation tube, in which is placed the sample and the mixture of the two chromates. This tube is set into a small oil-bath heated by a micro-burner M. The temperature is kept at 115-125° C, so that the sulphuric acid is kept below the boiling point. A is the tube containing about 7 cc of sodium hydroxide and 1 cc of perhydrole to absorb the chlorine and bromine. H_2 is a stop-cock which allows the solution to run into an Erlenmeyer flask.

Apparatus from Eck & Krebs, 131 West 24th St., New York City. ($10.00.)

Reagents. Solutions: 0.01 N sodium hydroxide; 0.01 N hydrochloric acid; conc. sulphuric acid, Sp. Gr. 1.84.
Dichromate mixture: 1 part silver dichromate
1.9 parts potassium dichromate
Perhydrole: Merck or Kahlbaum—acid free. Determine factor 1 cc in water against base.
Oxygen; oil-bath; methyl red indicator.

Procedure: The oil-bath should be heated to 115°-125° C and this temperature maintained during the experiment. Between the oxygen tank and the apparatus, there should be a gas-bottle with sodium bi-carbonate solution, and the oxygen flow about 10 bubbles in 6 seconds. For a substance containing chlorine, the sample should be 4 to 5 mg; for bromide determination, the sample should be 5 to 6 mg. The sample should be weighed directly into a micro-porcelain boat. Before putting the sample into the tube below the dropping funnel, add about 0.3 gram of the dichromate mixture. Now attach the tube containing both the sample and the chromates, to the dropping funnel by means of the small springs provided to keep the ground glass stopper perfectly gas-tight. In the absorption tube A, put about 7 cc of 0.01 N sodium hydroxide to which has been added 1 cc perhydrole. Place 3 cc conc. sulphuric acid in the dropping funnel. Now attach the L tube on top of the dropping funnel, and open the stop-cock to allow the sulphuric acid to drop on the sample and the dichromate mixture, and turn on the oxygen.

Allow the oxidation and absorption to continue for 20 minutes. Then open the stop-cock H_2 and allow the absorption solution to flow into an Erlenmeyer flask; wash out the tube with about 4 cc of distilled water.

Then add two drops of methyl red indicator to the solution and heat to boiling, then titrate with 0.01 N Na OH until the color of the solution is canary yellow. Record the readings of the burettes and make the proper correction for the acid in the perhydrole.

Calculation: X=halogen
log%X=log At.Wt.X+log cc 0.01 N NaOH+(1—log Wt. sample)

Analyses

Substance	Sample	cc NA OH	% Found	% Theor.
Chlorobenzene	4.645 mg.	2.95	22.57	22.66
Tri-chlor-aniline	4.459 mg.	6.78	53.92	54.13
Tri-Brom-phenol	5.247 mg.	4.66	72.54	72.41
Dinitro-trichlorbenzol	4.909 mg.	5.43	39.22	39.16

For substances with C H O and Cl or Br; not for compounds with N or S or volatile substances.

By many analysies we proved the accuracy of this method. The average time for a complete analysis is 50 minutes.

Comparison with Macro Method

Carius method of halogen determination by *macro* methods according to: Cumming, Hopper & Wheeler, 1931, pp. 468-473.
Gatterman & Wieland, 1932, pp. 65-67.

Weighing of tube	5 minutes
Weighing of tube and sample	5 minutes
Filling the combustion tube	5 minutes
Sealing the combustion tube	15 minutes
Compounds that oxidize easily	2 to 4 hours
Compounds that do not oxidize easily	8 to 10 hours
Cooling of the combustion tube	2 to 6 hours
(Danger of explosion due to pressure)	
Reheating the tube	1 hour
(Danger of broken glass with halide)	
Washing out precipitate and washing out tube with distilled water	15 minutes
Heat beaker to boiling	15 minutes
Prepare Gooch crucible and filter	30 minutes
Wash with distilled water	10 minutes
Dry precipitate in air-bath	30 minutes
Heat crucible and weigh to constant Wt	40 minutes
Calculation	5 minutes

N.B. The minimum of 15 hours required for this macro method, and often 20 hours are necessary. The Zacherl-Krainich method complete in 1 hour.

SOME NEW LABORATORY APPLIANCES

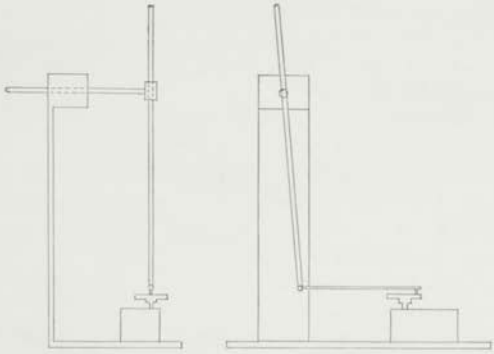
REV. ARTHUR J. HOHMAN, S.J.

A New Laboratory Shaker. A shaker was needed which would give the maximum displacement at the bottom of the vessel being shaken. The shakers usually described in the Apparatus Catalogues produce greater motion at the top. A shaker of the type desired was designed by Dr. Claude R. Schwob and constructed in our workshop.

A wooden plate, 24″ long by 11″ wide was taken as a base. To the rear of this plate and toward one end was fastened an upright 23″ long and 4″ wide. A bearing block was attached to the top of the upright, the block measuring 3″ by 4″. Rigidity was secured by means of 3"x4" pressed steel brackets where the upright met the bearing block and the base respectively.

A 3/8" hole was drilled in the bearing block from front to back, and the short arm of a Farmer Universal Support inserted. The long arm of the support, held securely by means of the set screw attached, served as rocker arm. A wooden collar in front and a pulley in the rear served to keep the axle from riding back and forth.

A New Shaker



Side Front

A used phonograph motor was then procured and fastened to the base plate. The disk of the motor was replaced by a 3" cast iron pulley, with a flat face, mounted horizontally. The pulley was drilled at a distance of 1-¼" from the centre. A flat strip of brass ½" wide and 3/32" thick served as a connecting rod and was attached to the rocker arm and pulley respectively by means of loosely fitting machine screws fitted with lock nuts. The connection with the rocker arm had to be made quite loose due to the change of angle as it rocked back and forth. This causes a very slight click when the shaker is in operation.

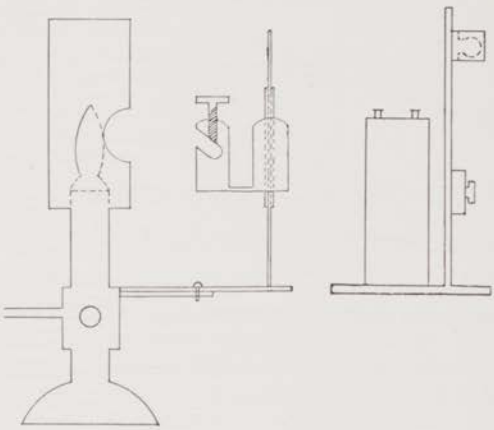
The rocker arm has a maximum displacement at the bottom of 2-½". The flask can be attached to this arm at varying heights by means of a clamp with holder attached. By this means it is possible to shake a flask attached to a stationary gas burette by means of rubber tubing, with the minimum disturbance at the rubber joint. This is accomplished by locating the end of the glass outlet tube at the axis of rotation. The motor in use is capable of shaking a one liter glass stoppered bottle 1/3 full of liquid.

Adaptation of a Polarimeter Lamp for use with the Spectroscope

A Sodium Light Polariscope Lamp, gas heated, was adapted for use with the Spectroscope in routine work in the Analytical Laboratory in the following way.

An extension was attached by means of a single machine screw to the side arm which carries the upright for the sodium spoon. The upright was then mounted at the outer end of this extension. The following device was constructed and mounted on the same collar which carried the sodium spoon.

Two small, French type, binding posts were soldered to a short brass strip, as close together as practicable. One was drilled to fit tightly over the sleeve which can be pushed up and down the upright, and rotated. The other was slotted at the top, the slot inclined slightly downward toward the inside. The slot was made large enough to hold a 5 mm. glass rod, such as is used as a handle for a Platinum wire. By means of the vertical screw of the binding post this rod can be clamped in the slot.



Polariscope Lamp
for Spectroscope

Scale
Illuminator

By means of the sleeve the Platinum wire can be rotated in and out of the flame. The shield around the flame is a great advantage in making observations. With the Platinum wire held mechanically the nervousness due to trying to observe the spectrum while at the same time holding the Platinum wire in proper position in the flame is obviated. Thus readings can be made more conveniently and accurately.

Both the extension and the holding device can be removed in a few minutes if it is desired to convert the lamp back to its original use. A shorter standard has to be used for the lamp, but this is made so that it is convertible with the longer one used for the polarimeter, and can be replaced by the latter in a very short time.

A Scale Illuminator

Due to breakage the scale on our Laboratory Spectroscope had to be replaced. The old gas flame used heretofore proved insufficient to illuminate the new scale. A very practical illuminator was constructed in the following way.

A two volt flash light bulb was mounted on the front of an upright, at the proper height, by means of a small porcelain socket. Two ordinary laboratory dry cells, not the small battery type, were put in series and placed on the base to which the upright had been attached. These were connected with the bulb by means of a small toggle switch mounted on the upright below the bulb. An old radio bulb socket made a convenient shield for the light.

This illuminator can be constructed at a very low cost and operates very efficiently, considerably improving the working of the spectroscope.

PHOTOSYNTHESIS: THE NATURE AND CHEMISTRY OF CHLOROPHYL

(Abstract)

REV. HAROLD L. FREATMAN, S.J.

This process of making food by the leaves of plants, is much involved, and its exact explanation is still awaited. Carbon dioxide, water, chlorophyl in the leaf, light, and a proper temperature are the raw materials for the manufacture of carbohydrates. Absence of light means lack of chlorophyl. According to most investigators carbon dioxide and water in nature have a tendency to unite to form carbonic acid and then decompose to formaldehyde; the latter's molecules quickly polymerize to give simple sugar, which lose a molecule of water and polymerize to form starch and cellulose. It is disputed as to what is the first fruit of photosynthesis. The process, taking place in living calls, cannot be duplicated in the laboratory.

Choroplsts, variously shaped, are of doubtful origin. They contain a yellow-green pigment, which may be separated into chlorophyl—a, chlorophyl—b also xanathophyl, and carotin, two blueish-green, one yellow, one carrot-color. Ch-b, Ch-a make up 72%; then Ch-a exists in the proportion of 72% to 28% of Ch-b. The chemical composition of Ch. is very complex, but at least N, C, H, O, Mg are present in proportion. Presence of nitrates favors Ch-formation, NaCl impedes its formation, which fact may explain paleness of plants in salt-marshes. Methyl-alcohol, petroleum-ether will divide

Ch fractionally into Ch-a and Ch-b. Olive-green solution, pheophytin, comes from Ch-a when in solution; and Ch-b in solution is yellow-green, whose Mg-free derivative is red-brown in neutral solutions. Both Ch-a and Ch-b agree in Mg-content and phytol content, but differ probably in a molecule ofO)—two hydrogen atoms of Ch-a being replaced by an oxygenation in Ch-b.

Fresh leaves contain about 2 parts of Ch-a, in a 1000, ¾ of Ch-b, 1/3 of xanthophyll, 1/6 of a part of carotin. Iron is not integral to formula of Ch, but is considered essential to its formation. Although Chlorophyl and Hemin of the blood have been traced to the same etioporphyrin like a parent substance, yet there is no close constitutional relationship, as in Ch there is Mg, the other Fe; in the ester-formation with theoil phytol, in the other a combination with globin. There are further differences in the nucleus of the pigment. Some say that porphyris from Ch and Hemin are similar, not identical. From this some would trace the common origin of plants and animals. With alkalies Ch, which is a dicarboxylic ester of phytol, is hydrolysed, also with methyl alcohol. If the phytol is eliminated, the monomethyl ester, which remains, is termed Chlorophyllide; the latter on hydrolysis yields green salts of acids, the chlorophyllins which contain 1, 2, 3 cerboxyl groups. All receive their name from their color, glauco-rhodo-cyano-erythro-rubi-pyrro. By systematic decomposition we get a carboxyl-free parent etio-phyllin. All the phyllins contain one atom of Mg to four of N. Under the influence of acids all phyllins lose Mg and are transformed into polybasic carboxylic acids which show basic and acid properties. Since all these form a natural group with phylloporphyrin, they are called porphyrins, each with the prefix of the corresponding phyllin. The meal of dry nettle leaves is a good source for experiment.

MATHEMATICS

A PROBLEM AND PROPOSED SOLUTION

REV. JOHN P. SMITH, S.J.

The Department of Mathematics of St. Peter's College determined to give at the beginning of the school year an algebra test to the Freshmen who were enrolled in our Mathematics course. We wished to discover any deficiency in their ability to handle simple fractions, equations and exponents and, if possible, to make the needed corrections before it was too late to prevent failure. With few exceptions, these Freshmen had studied algebra in their first two years of high school. We therefore gave them ample time to make a necessary review. Ninety-six students coming from forty high schools took the test. The following table gives the problems with their respective percentage failures:

Add $1/3 + 1/4 + 1/5$	1%	Solve simultaneously for X $2X + 3y = 13$, $5X - 4y = 16$	39%
Divide $\frac{3/4}{7}$	25%	Solve for t $\frac{1}{a} + \frac{1}{b} = \frac{1}{t}$	52%
Divide $\frac{12}{1/3}$	15%	Solve for t $S = \frac{1}{2} a t^2$	46%
Divide $\frac{3/4}{5/8}$	15%	Solve for t $t^{1/2} = 3$	53%
Simplify $\frac{X^2 - 3X + 2}{X^2 + 3X - 4}$	22%	Multiply $X^{1/2}$ and $X^{-3/2}$	32%
Simplify $\frac{1}{a^2 - b^2} - \frac{a - b}{a + b}$	71%	Simplify $2\sqrt{a} + 3\sqrt{a} + 5\sqrt{b}$	22%
solve for X $\frac{X + 1}{X - 1} = \frac{5}{3}$	19%	Simplify $(\sqrt[3]{a})^6$	57%
Solve for X $8 + 2X - 19 = X$	9%	Multiply $2\sqrt{2}$ and $3\sqrt{8}$	52%

We made our conclusions after an analysis of the mistakes found in the correcting of the test papers. These conclusions are evident from the above resuts. About twenty-five per cent of the entire group need a review of the elementary course in algebra. Most of this group lack a knowledge of the simple rules of fractions, equations and exponents. We have therefore the problem of giving these the necessary instruction outside of regular class. Five upper classmen who have shown proficiency in their mathematical courses have been selected as tutors. Each tutor will have a group of five or six. Attendance in these classes has been made compulsory. As a work book we have selected "Review of Pre-College Mathematics" by Lapp, Knight and Rietz, published by Scott, Foresman and Company.

In this connection it is interesting to compare the above test with a somewhat similar but more extensive test given in five Iowa Colleges, with this difference—that our test was given at the beginning of the school year to all Freshmen in the Mathematics course while theirs was given near the end of the first year Physics courses. The percentage failures are similar. For the problem $t^{1/2} = 3$ they had 68% failure, ours was 53%; for the problem $\frac{3/7}{3}$ they had 28% failure, while for our problem $\frac{3/4}{7}$ we had 25% failure. A study of the Iowa test may be found in "The American Physical Teacher", Feb. 1934.

A detailed analysis of the more common mistakes made has been given to each instructor, so that he may call attention to them during the year. The important fact for the instructor is that he knows who came to his class deficient in algebra, a fact worth knowing in case of failure at the end of the term. We too have realized how the test can be improved in future years.

RECENT BOOKS

Mathematics

Algebraic Surfaces (Ergebnisse der Mathematik, III,5) ...... O. Zariski
Vienna: J. Springer (1935) .... (R. M. 22.75)

Algebren (Ergebnisse der Mathematik, IV, 1) .... M. Deuring
Vienna: J. Springer, (1935) .... (R. M. 16.60)

Gruppen von linearen Transformationen (Ergebnisse der Mathematik, IV,2) .... B. L. van der Waerden.

Vienna: J. Springer (1935) .... (R. M. 8.80)

The Calculus of Variations in the large (A.M.S. Colloquium publications, 18) .... M. Morse

New York: The American Mathematical Society (1934) $4.00

Physics

The Principles of Quantum Mechanics .... P. A. M. Dirac

London: Oxford University Press, 1935 (2nd ed.) (17s. 6d.)

The Measurement of Inductance, Capacitance and Frequency.
A. Campbell—E. Childs

London: The Macmillan Company (30s.)

The Structure of Spectral Terms .... W. M. Hicks

London: Methuen and Co., Ltd. (10s. 6d.)

Relativity Physics .... W. H. McCrea

London: Methuen and Co., (1935) (2s. 6d).

Luminescence des Corps Solides .... M. Curie

Paris: Les Presses Universitaires de France (50 fr.)

Some Problems of Modern Meteorology

London: Royal Meteorological Society, 49 Cromwell Rd. S.W.7.
(3s. 6d.)

Physical and Dynamical Meteorology .... D. Brunt

Cambridge, England: Cambridge University Press (1934) (25s.)

METEOROLOGY

CLOUD PHOTOGRAPHY AT THE MANILA OBSERVATORY

REV. CHARLES E. DEPPERMANN, S.J.

In order to correlate clouds with the various types of air currents that reach the Philippines, the Manila Observatory in May 1934, started a year's photography of clouds. Now that the program has been successfully completed, a few words as to the plan of campaign and the results achieved may be of interest.

It was quite a problem to decide upon the best method of procedure. Many have advocated the use of a cylindrical or "fish-eye" lens, of the type suggested by Dr. Wood in his "Physical Optics", or at least some very wide angle lens, enabling the photographer to cover most of the sky in one picture. This would be an advantage, of course, if it could be done cheaply and efficiently. However, a lens of this type would be very expensive, and a special shutter would be imperative to get proper distribution of light intensity. Experience, moreover, has shown the writer that the sky very often shows remarkable contrasts in light intensity, especially in stormy weather, and no shutter would be equal to the task of bringing out properly all parts of the sky in one picture. Even with an ordinary camera, with its limited field of view, certain pictures have to be consistently rejected, unless the photographer when printing is prepared for the task of delicate "dodging," i.e. of shading parts of the negative. To take several pictures at a time of *ordinary size*, say 4"x5", or 5"x7", selecting characteristic parts of the sky, is another alternative, but the cost would be very high, if one wishes, as I did, to take some twenty or more pictures a day, and often, in striking situations, five or six almost at once. The frequent loading of the ordinary rolls of six or eight pictures would also be very inconvenient.

After much deliberation, the following scheme was adopted, and it has proved quite satisfactory, and the cost, though considerable, has not been prohibitive, considering the ambitious nature of the project. A Contax camera was purchased, using movie film, 36 pictures to a roll, but taking a picture twice as large as the ordinary movie camera. The size is admittedly small, but the definition is excellent, and with the aid of an ordinary reading glass, all necessary cloud detail can usually be seen. A diary was kept of exposure times, the general sky and weather conditions at the time of taking the picture, together with positive, actual size pictures. The diary, at the end of the year, contained some five thousand pictures of clouds. Some six hundred of the best, typical pictures have been enlarged to size 5"x7".

A few more details will now be given as to the camera and method of procedure:

The camera and lenses: The camera used was a Zeiss Contax. At first a wide-angle lens was adopted, giving a field of view of about ninety degrees (Zeiss Tessar 1:8, f 2.8 cm.) However, when a filter was put on (a light yellow one), the wide angle at which the light met the filter caused much reflection, and as a result the outer parts of the picture very often showed serious under exposure. Hence an ordinary Zeiss Tessar (1:2.8, f 5 cm.) was purchased and has proved very satisfactory for all around work. The wide-angle lens was reserved for those pictures of clouds (e.g. large thunderstorms) which occupied too much territory for the ordinary lens, but *no filter* was used with it. Usually the wide-angle lens, so used, gave sufficiently satisfactory results, but not always.

A light yellow filter was used with the ordinary lens, since trial with a dark yellow filter showed practically no improvement in detail. In fact, the Agfa Panchromatic films could almost be used without filter most of the time.

Films: In the tropics, one cannot always get the films one desires, and we were compelled to start out with Superpan films. For the natural size small positives, this gave good results, but when enlargements to 5"x7" are in question, or projection on a screen, then the grain of the Superpan becomes quite perceptible. Isopan films were used as soon as they arrived in Manila; and these gave a smaller grain. Finally during the last month of work, the Finopan came, which for fineness of grain leaves really nothing to be desired.

Development: Fine grain developers of various type were tried, but they all proved unsatisfactory, due to lack of sufficient contrast in the negatives. Delicate cirrus clouds, or misty cloud effects, etc., would not come out properly; the fine details were lost, and many pictures, too many in fact, were quite flat. We therefore perforce had to use a contrast developer; but, alas, this also enlarged the grain! The grain, however, though at times not so pleasing to the eye on 5"x7" enlargements was not large enough to spoil details, and so for our films Eastman D-11 developer (time 5 minutes, starting at 16 degr. Cent.) has been almost exclusively used. It was thought better to possess the requisite cloud details with a somewhat larger grain on enlargements (of course on the small prints there is no trouble about grain), than to have smoothness with flatness and loss of detail. Perhaps in other climates, with clearer air, fine grain developers would work better. The films in the tropics after development must be very thoroughly washed. Father Doucette, Chief, Meteorological Section of the Observatory, kindly did all the developing of the films, while the writer took the pictures and did all the printing and enlarging. In this way, though it took much time, the cost of the program was considerably reduced.

Printing: For this, Eastman D-72 developer (home-made as was the D-11, by Father Doucette), diluted to proper proportions (1 part developer to 2 parts water) and Azo No. 5 or No. 3 paper, were used. *Very* thorough washing and the use of hypo *only once* were found necessary to prevent the prints from turning brown after some months.

Enlarging: To have 5"x7" enlargements made outside would have been very costly, and not so satisfactory, since the store would find it difficult to estimate rightly the proper shade of the clouds. It was found cheaper and much more satisfactory to make the enlargements ourselves, using a Zeiss "Magniphot." To get sufficient contrast on these enlargements, D-11 developer was again used, undiluted, and proved excellent when used in conjunction with News Bromide Contrast paper (or Medium for the more naturally contrasty pictures). With the new Finopan films, enlargements of this size, developed as indicated, give hardly any grain besides exquisite detail and contrast.

Taking the pictures: About twenty pictures a day were taken as a rule, the number varying with sky conditions, usually at intervals of one or two hours. An Ombrux exposure meter, which is reasonable in price and very satisfactory, was found an absolute necessity to guage exposures of clouds correctly. One had to learn, too, not to take pictures too near the sun or with too much contrast; this is especially true for pictures of squalls, storm clouds of various kinds, etc. The eye has a remarkable power of adaptation to varying degrees of light intensity, and only an exposure meter insures consistently good exposure times. This consistency is a necessity, for it must be remembered that the film roll has 36 pictures, and there can be no individual development, and this latter must be done in a tank in perfect darkness, since the films are so very sensitive to light. Even with a yellow filter, the ordinary exposure time used was 1/100 second, stop 8.

So much for the method. Now there remains the onerous task of studying the pictures in relation with the weather map. It will, in all probability, be a year or more before the result of such analysis can be published.

PHYSICS

SUN-CONDITIONING

BERNARD A. FIEKERS, S.J.

"Sun-conditioning" applies the laws of reflection to general interior day time illumination. At present it is in the experimental stage, but makes a fair bid to demand consideration in the appointments of large office buildings and apartments of the future, where the lighting problems are most acute.

In construction, this sun-conditioning apparatus resembles a large scale reproduction of the physicist's port-lumiere. The first installation stands on the roof of a building in the Hague, Netherlands. It consists of a large mirror of about nine square meters in area, together with a system of mirrors designed to take the sun's reflection from the first, and bring it indoors.

The first mirror is mounted with astronomic precision, and so moves that it always faces the sun. Its revolution is governed by a driving motor, which in turn is governed by a heliostatic device. Two mercury bulbs in the heliostat are heated by the sun. When the maximum heat is attained, the upper levels of the mercury make contact and cause the action of the driving motor to cease. As the sun progresses in its course, the mercury cools down, contact between the two mercury portions is broken and the driving motor is again engaged, until the mirror has again caught up with the sun.

Thus, apart from a certain lag, the mirror is continuously facing the sun in the daytime. The light is then reflected into another large mirror which in turn reflects it down the central court yard of the building. Other mirrors are placed at various windows in the court as well as in the skylights at the very bottom. From these the light is reflected onto the white ceilings within the building. The light is also sent through a shaft into the cellar of the building where remarkable lighting is effected.

The mirrors, though large, are not expensive. For the larger ones are made up of small six by six inch sections. Steel beams support the entire apparatus so as to keep it steady.

As described to the writer, the first installation provided four square meters of light,—equivalent, on the average, to 400,000 lumens. As a rule, 60% efficiency was attained in reflection, leaving 240,000 lumens. These were divided "ad libitum" over 500 to 1000 square meters. Each square meter received 240 to 480 lumen. One "lumen per square" meter, I am told, constitutes one "lux." These results compare favorably then with the work of the electrician who is ordinarily satisfied with 50 to 80 lux. There are advantages and disadvantages. But the economy involved has the greatest appeal among Europeans, who probably husband their resources more carefully than we in America.

The apparatus is patented in the principle countries, including our own. The Netherlands Arthel Co. holds the patents here. The concept is due to a man by the name of Arthuys, with whom Professor Bayle, of the Institute d'Optique in Paris, cooperated. Hence the name "Arthel" from "Arthuys", the inventor, and "Helios" for sun. To Professor Bayle, we are indebted for three heliostat designs, each of which involves a different optical principle.

Apart from the essentials mentioned, other automatic control equipment is found in this device. It includes equipment designed to bring the revolving mirror to the east in the morning.

Representatives of the Dutch Government have visited the first installation and approved the work. There now stands a second installation in the General Post Office at Amsterdam. It is not insignificant to find that a representative of the Church has also paid a visit and blessed the work. For in the list of visitors at the Hague there stands the signature of the very reverend Bishop of Harlem, the late Msgr. Augenent. His support was most enthusiastic. His interest bespeaks the Catholic's appreciation of one of God's greatest gifts, the sunlight.

LECTURE AND LABORATORY SUGGESTIONS

REV. THOMAS H. QUIGLEY, S.J.

For cross-hairs in microscopes, etc.: "Silica Cotton".
Toledo, Ohio: Owens-Illinois Glass Company.

Simple Filters for Isolating Lines in the Mercury Spectrum
A. J. Maddock
London: Journal of Scientific Instruments (July, 1935)

A Capacity Measuring Bridge (A method of determining a capacity by means of a Post Office box and a ballistic galvanometer.)
Wright-Graham
London: Journal of Scientific Instruments (July, 1935)

A Linear Scale for the Direct Measurement of Slopes of Curves
L. Chilton
London: Journal of Scientific Instruments (June, 1935)

The Use of a liquid surface carrying ripples as a diffraction grating
R. Brown
London: Proceedings of the Physical Society (Sept. 1, 1935)

The Development of the Photographic Lens........................Taylor-Lee
London: Proceedings of the Physical Society (May 1, 1935)

Five Papers on the Theory of Probability
Cambridge, Mass.: Journal of Mathematics and Physics (M.I.T.)
(March, 1935)

SEISMOLOGY

THE NEW SEISMOGRAPH STATION AT KINGSTON, JAMAICA

Rev. John P. Delaney, S.J.

The following notice, contributed by the present writer, appears in the September, 1935, issue of Earthquake Notes, publication of the Eastern Section, Seismological Society of America.

"Through the generous cooperation of the Geophysical Laboratory, Carnegie Institute of Washington, and of the Seismological Laboratory, Georgetown University, instrumental equipment has been assembled for the new seismograph station to be opened at St. George's College, Kingston, Jamaica, B. W. I. The new station, in charge of John A. Blatchford, S.J., will operate as a member station of the Jesuit Seismological Association, cooperating with the U. S. Coast and Geodetic Survey.

"The new Kingston project has been endorsed enthusiastically by Captain N. H. Heck of the Coast Survey, by Dr. James B. Macelwane, S.J., President of the Jesuit Seismological Association, and by Prof. R. M. Field, Vice-Chairman of the American Geophysical Union. Kingston is strategically located for study not only of the active Caribbean region but also of the even more important seismicity of Panama and Nicaragua. Initial equipment for the new station includes a Wood-Anderson long period torsion seismometer loaned by the Carnegie Institution and recording drum, lamp and clock loaned by the Georgetown Observatory."

Interest in the present Kingston project began with a chance conversation between His Excellency, the Most Reverend Thomas A. Emmet, S.J., Vicar Apostolic of Jamaica, and the writer. The Bishop manifested intense interest in the study of earthquakes and he stated that a seismograph station in Jamaica would not only yield earthquake data of importance but would also contribute to the prestige of the Jesuit educators and missionaries at St. George's College and the various missions. His Excellency added that he hoped some day to find a benefactor generous enough to donate the several thousand dollars required for opening a station at Kingston.

Subsequently the writer applied to the Carnegie Institute of Washington for assistance toward the establishment of a seismograph station at Kingston. The Institute offered the loan of a Wood-Anderson long period torsion seismometer on condition that the other necessary equipment, observatory clock and recording drum, could be obtained elsewhere. This offer follows the practice of the Carnegie Institute and other research promoting agencies. These agencies lend the needed equipment, never donating it, and always on condition of further cooperation and subsidy on the part of the college or university. Georgetown University through the kindness of Father W. Coleman Nevils, S.J., Rector, and Father Frederick Sohon, S.J., Seismologist, generously offered the loan of the required additional instruments. Other assistance toward the new station materialized in a substantial donation from a benefactress in Buffalo to cover packing and shipping of the instruments. The instruments were professionally packed by the American Instrument Company, and the balance of the donation was forwarded to Bishop Emmet toward the cost of installation. The instruments arrived in perfect condition and were put on public exhibition while the vault was being excavated.

Several important considerations favor the loan of equipment for the new station. First, the loan immediately links the new station with old and well recognized institutions, Carnegie and Georgetown, offering assurance of prestige and public recognition from the start. Second, without financial loss the site may be tested experimentally for tilting or other disturbing effects, the presence of which would preclude the proper functioning of this or that type of seismometer. Thirdly, the first loan opens the way to further future subsidy and assistance, and the valuable research is opened without indefinite procrastination.

RECENT SCIENTIFIC PUBLICATIONS OF OUR UNIVERSITIES AND COLLEGES

The following list is a supplement to the list of publications, Volume XII, No. 4, pages 197 to 206, May 1935.

MANILA OBSERVATORY, Manila, P. I.

Upper air at Manila by Fr. Deppermann, Vol. II, No. 5, Publications of the Manila Observatory.

The Climate of the Philippines by Fr. Deppermann, Port of Manila Year Book, 1934.

Cloud Photography at Manila Observatory, Monthly Weather Record, U. S. Weather Bureau, by Dr. Deppermann.

5000 Small contax pictures of Manila clouds, and 600 enlargements of same.

Two years of meteorological observations at Haight's place, by Fr. Miguel Selga. University of the Philippines. Natural and applied science bulletin, vol. III, pp. 241-244.

Report on the temperature and rainfall of Tagaytay, Cavite, by Fr. Miguel Selga. University of the Philippines. Natural and applied science bulletin, vol. III, pp. 245-249.

Preliminary report on the weather at Mantalongon, by Fr. Miguel Selga. Bureau of Printing, Manila, 1934. 34 pages, with plates and illustrations.

Brief History of the Manila Observatory, by Fr. B. F. Doucette, S.J., American Meteorological Society Bulletin, February, 1933.

Activities of the Manila Observatory, by Fr. B. F. Doucette, S.J., Year Book, Manila Harbor Board, 1934.

Various Articles by Father Deppermann in the Science Bulletin.

Various Articles by Father Repetti in the Science Bulletin.

Annual Report, Philippine Weather Bureau, Part III 1928.

Annual Report, Philippine Weather Bureau, Parts I and II 1929.

Annual Report, Philippine Weather Bureau, Part III 1929.

Annual Report, Philippine Weather Bureau, Part IV 1929 (Magnetic)

Annual Report, Philippine Weather Bureau, Parts I and II 1930.

Annual Report, Philippine Weather Bureau, Part IV 1930 (Magnetic)

Annual Report, Philippine Weather Bureau, Parts I and II 1931.

Meteorological Bulletin, Philippine Weather Bureau, Jan.-June, 1932.

Seismological Bulletin, Jan.-June, 1932, by Wm. C. Repetti, S.J.

Seismological Bulletin, July-Dec., 1932, by Wm. C. Repetti, S.J. Contains article "The Benguet Earthquake of Aug. 24, 1932".

Seismological Bulletin, Jan.-June, 1933, by Wm. C. Repetti, S.J.

Seismological Bulletin, July-Dec., 1933, by Wm. C. Repetti, S. J. Contains article "Very Deep Earthquake in the Philippines".

Seismological Bulletin, Jan.-June, 1934, by Wm. C. Repetti, S.J. Contains article "The China Sea Earthquake of Feb. 14, 1934".

Seismological Bulletin, July-Dec., 1934, by Wm. C. Repetti, S.J. Contains articles:
"The China Sea Earthquake of Nov. 26, 1934", and "Tectonic Lines of the Philippine Islands".

"Preliminary Investigation of Microseisms in Manila", by Wm. C. Repetti, S.J., Gerlands Bertrage zur Geophysik, Band 40, Heft 2/3, 1933.

"Philippine Earthquakes and the Mariner", by Wm. C. Repetti, S.J. The Port of Manila, Year Book 1934.

"A Correction to Wichmann's Catalogue of East Indian Earthquakes" by Wm. C. Repetti, S.J., Gerands Beitrage zur Geophysik, Vol. 43, 1934.

"Structure of the Earth's Outer Crustal Layers in the Region of the Philippine Islands" by Wm. C. Repetti, S.J., Proceedings of the Fifth Pacific Science Congress, Canada, 1933.

"Los Mapas de Filipinas por el P. Pedro Murillo Velarde, S.J.," by Miguel Selga, S.J., Publications of the Manila Observatory, Vol. II, No. 4.

PUBLICATIONS IN SEISMOLOGY

Taken from the "Bibliography of Seismology", issued by the Dominion Observatory Ottawa, Canada.—Vol. XII, No. 5.

Rev. E. Gherzi, "Le Probleme des microseismes et le deferlements des Vagues", Zeit. Geoph. Jahr, 10, Heft, 7.

Rev. J. B. Macelwane, "Keeping Tabs on Earthquakes", St. Louis Globe Democrat Magazine, Nov. 18, 1934.

Rev. Neumann Navarro, "La Sismologia", Iberica, Nov.-Dec. 1934.

Rev. W. C. Repetti, "A Correction to Wichmann's Catalogue of East Indian Earthquakes", Ger. Bei. Bd. Heft. 3.

From the same, Vol. XII, No. 6.

Rev. E. Gherzi, "Some Results Obtained by Means of a Short Period Galitzin-Wilip Seismograph at the Zi-ka-wei Observatory", Proc. Fifth Pacific Science Congress, 1933.

Rev. J. B. Macelwane, "The Seismological Work of the Jesuit Seismological Association in the U. S.".

"The Structure of the Outer Crust of the Earth in the Pacific Ocean Region."

both in Proc. Fifth Pacific Science Congress, 1933.

Rev. Neumann Navarro, "La Repartition des epicentres sismiques calamiteux en Italie", Bul. Soc. Belge d'Astron, Jan.-Feb. 1935.

"Le. R. P. Bonaventure Berloty", Rev. Questions Scientifiques, Mar. 20th, 1935.

"Notas sismicas de 1933", Iberica, Mar. 9th, 1933.

Rev. W. C. Repetti, "Structure of the Earth's Outer Crustal Layers in the Region of the Philippine Islands", Proc. Fifth Pacific Science Congress, 1933.

From "Earthquake Notes and Abstracts Proceedings of 1935, Meeting of Eastern Section Seismological Society of America, Ottawa, Canada, Sept. 1935. Vol. VII, No. 1 & 2.

At the Ottawa Meeting May 27th, 1935, Rev. F. W. Sohon was elected Secretary. The following papers were read by Ours.

"Seismograph Tilt Recording", by Rev. J. P. Delaney.

"A Preliminary Sketch of the Seismic History of Missouri", by Rev. J. B. Macelwane, and D. C. Bradford.

"A New Vector Wave Motion Theory", by Rev. G. A. O'Donnell, S.J.

"Report on Twenty-four Weeks of Microseismic Activity", by Rev. F. W. Sohon, S.J.

"Progress Report of the Jesuit Seismological Association", by Rev. J. P. Macelwane, S.J.

In this same Publication the announcement is made of the establishment of a new Seismological Station at St. George's College, Kingston B. W. I. in charge of Rev. J. A. Blatchford.

Note: Rev. George Brunner of the Dept. of Geophysics at St. Louis University, St. Louis, Mo., has recently published his Focal-Depth-Time-Distance Chart for earthquakes. With the data given by seismograms it is possible to read off directly from a series of curves the time of origin, distance and depth of focus of an earthquake. Fr. Brunner gave a description of the chart at the Fordham Meeting of the Eastern Section of the Seismological Society of America in May 1934. Published by J. Wiley & Sons, New York.

NEWS ITEMS

Pope Pius XI Praises The Work of Father Stein and Father Hagen, Jesuit Scientists

On Sunday, September 29, 1935, the Holy Father inaugurated the newly completed Vatican Observatory at Castelgandolfo in the presence of a large company of distinguished ecclesiastics and scientists. After the address of homage had been read by Father Stein, S.J., Professor Bianchi, Director of the Royal Observatory of Brera, read an address on behalf of the astronomers of Italy.

His Holiness in replying said: "The Astronomical Observatory and the Astral Institute which we inaugurate officially today, makes us think confidently that the better scientific instruments We have procured, and the proved scientific value of the men to whom it is entrusted, will render no insignificant contribution to the study and progress of a science which amongst the sciences may be well said to be sovereign—the science of the heavens—but this is not the only thought that gladdens Us to-day."

"We have had a sober, but wise and most attractive sketch given Us by Our dear and valiant Father Stein, S.J. At a glance We have seen opened for a moment the profound 'abyss of the heavens', and enjoyed certain notes of that immense and solemn hymn in which the heavens and the stars sing the glory, the power, the wisdom and infinite beauty of the Creator." . . .

"The recent imposing Congress of Orientalists in Rome has also recalled and illustrated these relations in certain papers read there, relations which are found in the most ancient cuneiform texts, which reveal astral observations in order of sacrifice and cultural institution. And of yesterday (in face of this antiquity) is the reform of the Calendar which bears the name of Our great ancestor—Gregory XIII—and the part which astronomy played in his time, which has been highly appreciated by judges as competent as Schiapparelli and Father Hagen, S.J., not to mention others personally known to Us." . . .

Loyola College, Baltimore, Maryland, Chemistry Department

On October 10, Dr. Donald V. Cooney, M.D., Professor of Neurology, Columbia University, New York City, who was awarded the Lisseaur Honors of Yale University for 1935, lectured to the mem-

bers of the Loyola Chemists' Club on the subject: "The Crossroads of Chemistry and Medicine."
on October 29. The subject was: "The Evolution of Iatro-Chemistry at Maryland University, gave an instructive and interesting lecture on the development of Medical Chemistry, to the Chemists' Club on October 29. The subject was: "The Evolution of Iatro-Chemistry."

Another non-resident lecturer was the guest of the Chemists' Club on November 14: Dr. Hugh S. Taylor, D.Sc., from the Chemical Research Laboratory of Princeton University, Princeton, New Jersey. The topic of Dr. Taylor's lecture was: "Catalysis at Reaction Surfaces."

Manila Observatory, Manila, P.I.

Rev. William Repetti was appointed Chairman of the Section of Seismology of the Division of Physical and Mathematical Sciences of the National Research Council of the Philippine Islands.

Father Repetti returned to duty at the Seismological Observatory on July 22nd. The vision of the right eye is still distorted, however, with the aid of a reading glass he is continuing his researches.

Rev. Michael Selga, the Director of the Manila Observatory, attended the International Meeting of Meteorological Directors at Warsaw, U.S.S.R.

Pilot balloon ascents are now the regular routine of the Meteorological Department. Father Doucette will publish an article on this type of research work.

University of Santa Clara, California

Galtes Memorial Museum

In April, the University of Santa Clara formally reopened to the public the remodelled display rooms of mineralogical and coral specimens under the name of: THE GALTES MEMORIAL MUSEUM. The name perpetuates the memory of Santa Clara's beloved Professor of chemistry and eminent mineralogist, Father Paul F. Galtes, S.J., who died May 14th, 1934.

Father Galtes, quiet spoken, fervently religious, yet continually bubbling over with infectious humor, endeared himself to all who met him. He was an untiring student. His leisure was divided between cataloguing his mineral collection and studying current chemical and mineralogical journals. His scientific knowledge was a byword among his associates.

This mineral and coral collection was begun by Father Cichi, S.J., in the pioneer days of Santa Clara College. The corals were systematically begged from the masters of the South Sea trading ships, that docked at San Francisco. Some minerals were obtained in the same way; others by exploration, by trading and by purchase. Father Galtes, as high-school student and as undergraduate student, worked with Father Cichi, and later, as Jesuit, succeeded his Old Master. On his own part, he combed the entire Pacific Coast region and part of Alaska for new specimens. Many of his specimens were contributed by him to the Smithsonian Institute, Washington, D. C.

Santa Clara is now reaping the benefit of these untiring labors, for this mineral and coral collection is rated by mineralogists of neighboring universities as one of the best, if not *the* best, on the Pacific Coast.

Gonzaga University, Spokane, Washington

The Gonzaga Engineering School, which opened in September 1934, now has 60 students in Freshman and Sophomore. Courses are being offered in Chemical, Civil, and Electrical Engineering. Plans are being made to add Junior and Senior courses.

Due to the development of the Coulee Dam, there is a demand for electrical engineers. A complete line of electrical measuring instruments were added to the Engineering Laboratory, including: inductance and capacity bridges, heat frequency oscillators, audio amplifiers and oscilloscopes.

Courses offered at St. Michael's Scholasticate include: electrical measurements and atomic physics.

Mount St. Michael's was the centre of attraction and enquiry during the recent earthquake in the Northwest. From the many enquiries, it was learned, that many were under the impression that a seismograph is an instrument for predicting instead of simply recording earthquakes.

Three of Ours are in course for their Doctor's Degree: Rev. Francis J. Altman,—Seismology, at St. Louis University; Rev. Gerald Beezer,—Chemistry, at the University of Washington; Arthur McNeil,—Chemistry, at Catholic University, Washington, D. C.