The Reverend Pierre Lejay, S.J.
Jesuit Geophysicist
1898-1958

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THE REVEREND PIERRE LEJAY, S.J., 1898-1958

Rev. F. Russo, S.J.*

The Reverend Pierre Lejay died during the night of Oct. 10-11, 1958 as a result of a sudden cerebral hemorrhage on the liner *Flandre* as he was returning to France from the 8th General Assembly of the International Council of Scientific Unions which had convened in Washington, D. C., Oct. 2-6. As vice-president of the International Council, Father Lejay had taken an important part in the General Assembly as well as in the preceding gatherings of the bureau and of the executive committee of the same International Council.

Fr. Lejay was born on June 11, 1898 at Tamaris-sur-mer into a seafaring family. His father had been Rear Admiral in the French Navy during the First World War; two of his brothers, the oldest and the youngest were naval officers, the latter meeting his death as a submarine commander during the Second World War. Pierre, the Jesuit, was the third of the admiral's five sons. His brilliant studies at St. Aloysius Gonzaga in the rue Franklin in Paris culminated in two diplomas, the bachelor of philosophy and of elementary mathematics, when he was but sixteen years old. Although he had settled on his life's vocation at graduation, he studied for the Navy at the Lycee St. Louis in deference to the opinion of his father who thought that he was too young for the religious life. Due to wartime conditions there were no entrance examinations in 1915 but he did present certificates to the University of the Sorbonne in general mathematics and in advanced astronomy and passed with ease.

After the school vacations in 1915 he entered the novitiate, but his stay was a short one. He was mobilized and was wounded under fire. He had become an officer by the time of the Armistice. Colonel Ferrié, who had organized a course in advanced radio electricity for demobilized officers, welcomed Pierre Lejay among his students. This training and background induced his superiors to assign him in advance

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to the Observatory of Zi-ka-wei in China where he was eventually to succeed Father Chevalier, its Director. Meanwhile Pierre Lejay was finishing his licentiate, preparing his thesis, and completing his course in theology. He was ordained to the priesthood in 1926 and in that year he was awarded the degree of Doctor of Mathematical Science by the University of the Sorbonne.

On completing five years of service, 1922-1926, as a chronographer in the *Service Meridien* of the Paris Observatory, he was chosen to organize measures of longitude at the Zi-ka-wei Observatory. This observatory occupied a point on a triangular base for the general determination of world longitude, an internationally co-operative task which had been organized by General Ferrié. Difficulties to be surmounted in that distant country were serious and many; but a co-worker, Gaston Fayet, who helped with the observations, solved most of them in a satisfactory manner. The closing of the triangle, Alger, San Diego and Zi-ka-wei, to within a hundredth of a second were characteristic of Fr. Lejay's efficiency. Data were reduced within a few months and published as early as 1927, a year ahead of foreign publications.

In 1930, Father was appointed to the Directorship of the Zi-ka-wei Observatory. In this position he could give full rein as a physicist to his additional talent for organized production. So far from abandoning astronomy, in 1933 in conjunction with Gaston Fayet he published a second edition of *Mondiale et Longitudes*. One would think that his seven year interval, 1926-1933, would have been sufficient to settle the existence or non-existence of an increase in the separation of the earth's continents a well-known problem, as the German geographer Wegener had observed. Lejay found that the measure of separation over seven years was really less than the errors of observation.

Other undertakings in sequel to this one are of extraordinary interest in view of the great advances in astronomical chronometry through the study of time signals. Many publications of the day gave credit to the Zi-ka-wei Observatory and its learned director.

The basic objective of the meteorological observatory at Zi-ka-wei was the prediction of typhoons, disturbances that so frequently plague the western Pacific. Under Father's direction this objective was splendidly realized and became recognized even down to an apprentice-seaman in this part of the world.

Such interests carried Father Lejay from common atmospheric

problems to those of the upper atmosphere. The Observatory had facilities for magnetic measurements as well as for meteorological ones. He turned his attention again to radio reception with emphasis on the long range propagation of storm disturbances in electric fields and their complex characteristics. He studied too the automatic recording of radio signals and the altitude of clouds, not to mention visible spectra, and the high frequency excitation of rarified gases, introducing refinements of method still in vogue today.

In the field of meteorological physics he started with the spectrography of water vapor in the atmosphere and followed up with the absorption of solar radiation by atmospheric oxygen and dust. This train of investigation culminated in the study of ozone in the upper atmosphere. This would eventually lead to the central basis of his studies of the ionosphere for which he became renowned.

The ionospheric station that Fr. Lejay then set up at Zi-Ka-Wei was based on the *echo method*. He was the first to study both the variation in altitude and in reflectencies of ionized layers. He found that better results could be achieved when rectangular signals were used. This work led to the creation of the French Ionospheric Bureau in 1946 under the administration of the Post Office, with Fr. Lejay heading the Bureau. The value of the work of the Bureau lay both in the predictions (over two hundred messages per month over tremendous distances) and in other experimental and theoretical research as well, much of which found its way into the literature of the field. The residue of his notes contain studies on the formation of ionized layers, the mapping of their currents, absorption, polarization and the like.

In 1926 and 1933 Father was attracted to the problem of variations in his chronographs. He developed a remote synchronization system; abolished physical contacts in the pendula; and employed a CR oscillograph with photographic recording (*à déroulement rapide*). Naturally this work carried him into the use of pendula for the measure of gravity. He employed an inverted pendulum the mass of which was supported at its base with an elastic ribbon (*lame élastique*) so that one might say that the mass floated in the air. His collaborator in this fertile field was no other than Ferdinand Holweck who died at the hands of the *Gestapo* in 1943. The Holweck-Lejay inverted pendulum on an *Invar* (*à lame d'élinvar*) support was extremely difficult to fabricate so as to produce the best results. The

mass was almost completely equilibrated; the elasticity of the support minimizing variations in the system (*de telle sort que son équilibre fût presque indifférent*). The sensitivity of this instrument in measuring variations in *g* came to about two hundredfold that of ordinary pendula. Despairing of increasing the sensitivity any further, Father concentrated on simplifying the use of this instrument. He brought it to the point where one *mgal*, or six significant figures, could be achieved in an unbelievable twenty minutes. Naturally there could only be question of an interpolation instrument that required calibration. But it possessed the advantage of ease of use, the possibility of employing closed circuits, and accuracy of results. Thus it provided a superior instrument for getting at a basic geodetic problem, the weight of the earth, leading in turn to the more exact determination of the positions of the different continents (as opposed to the classical methods of triangulation), and even to the mapping of subterranean densities. Albeit great advances have since been made in the field of pendulum interpolation, still the Holweck-Lejay pendulum was unquestionably the first in the field and the senior survivor.

From 1933 Fr. Lejay began inspecting different sites around the world with a view to establishing a world-wide system of homogeneous gravimetric centers—a preoccupation of his in his later years. This included measurements in his French homeland during vacation time, in the Near East on the way to and from China, in Indo-China, in the Phillipines, and of course in China itself along its coast and in the interior.

In 1927 Father took part in the meeting of the International Geodetic and Geophysical Union and attended their subsequent triennial meetings. From the very beginning he was impressed with the importance of international collaboration, especially in his own fields of interest: geodesy, geophysics, radio reception and astronomy. A past master in organizational work, these fields in which human contact and discussion are of paramount importance, seemed to have been made to order for him. His success on a world-wide basis was astounding.

He served six years as chairman of the Gravimetric section of the International Geodetic Association. He was also entrusted with the founding and direction of the International Gravimetric Bureau, whose central task was to establish a homogeneous world-wide system for gravimetric observations. From 1950-1952 he was vice president, and from 1952-1957, President, of the International Union of Radio

Engineers. From 1955 on he was vice-president of all the great international scientific unions. In his French homeland, he was chairman of the National Committee for Geodetius and Geophysics from 1950-1956, a position in which he succeeded M. C. Maurain. In 1955 when there was question of the complex organization of the International Geophysical Year (IGY) he became a member of its International Organizational Committee and Chairman as well of its French National Committee. For him, his last function with this committee was far from being merely honorary. From Correspondent to the Bureau of Longitudes in 1937, he was elected titulary member in 1954; vice-president, in 1956; and President in 1958. He belonged to the National Center for Scientific Research and was Director of Research attached to the National Laboratory of Radio-electricity and Ionospheric Measurement. In 1935 he had been elected Correspondent for the Section on Geography and Navigation; and in 1946, a non-resident member of the French Academy of Science—this at a time when hopes could still be entertained that the expulsion of westerners from China would not be definitive.

If Pere Lejay was found to be more sensitive and timid a man than might be expected in a character such as his, considerable sufferings over the last years of his life might be invoked to account for it. Painful enough the ferocity of Envy to dislodge him from his position in Radio-electricity. The contradictions and schemings to which he was subjected brought on a serious stroke in June 1954, and a recurrence of it within two weeks. Despite good medical advice he persisted in preparing for the International Congress for Radio and Electricity at the Hague with the help of his co-workers. Taking all necessary precautions he arrived in the Hague courageously, resigned to the risks he took, and armed with the blessing of his Father Provincial.

These trials of the last years purged his soul and flooded him with an aura of peace in years of decline. Sick and conscious of it, he carried the Cross entrusted to him. To his intimates he betrayed simplicity, self-surrender and detachment of a soul prepared for the ultimate sacrifice. To die in harness without burden to anyone for his infirmity became his desire. In his last spiritual notes we find: "we never fulfill God's Will . . . the other formula is no formula. *Fiat Voluntas Tua.* Yes, let it be fulfilled as far as I am concerned in particular and let my perverse will, insofar as it is perverse within

the all too small restrictions of my liberty, never be an obstacle to His Plan. The effort required is the same, but in a totally different perspective, putting God in the first place." With these dispositions he faced his Creator.

His funeral took place on Saturday, Oct. 18, 1958, in the presence of a recollected group of mourners. Very Reverend Father Provincial celebrated the Mass. Before the absolution, given by his Excellency, Msgr. Villot, Rev. Fr. D'Ouince in a short address summarized the testimony to the Church which Father Lejay, scholar and priest, had rendered through his life. (Among the many savants present, those who were not Christians took a discrete part. We have to reserve their comments). On Oct. 27, 1958 a eulogy of Father Pierre Lejay was read in the presence of the members of the French Academy of Science by M. Tardi, Member of the Institute and Father's latest travelling companion. R. I. P.

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FR. T. N. BURKE-GAFFNEY, S.J., 1893-1958

Fr. Thomas Noel Burke-Gaffney, S.J., Director of the Riverview College Observatory, Sydney, Australia, died on Sept. 14, 1958. Fr. Burke-Gaffney was born in Dublin, Ireland in 1893 and entered the Jesuit Order in 1913. He went to Australia in 1928 and became assistant director of the Observatory in 1946 and director in 1952, replacing Fr. D. J. K. O'Connell who was made director of the Vatican Observatory. Fr. Burke-Gaffney played a valiant part in Australia's Geophysical Year work as convener of the National Subcommittee on Seismology. He published a number of papers. Those on the seismic aspects of nuclear explosions attracted world wide attention. (From *Nature* Nov. 15, 1958; in turn from Bull. Alb. Magn. Guild, Feb. 1959.)

CORRESPONDENCE

Fr. G. R. Edmonstone of St. Aiden's College, Grahamstown Cape Province, has written to the Editor, expressing appreciation of our publication and the work we are attempting to do. But the length of his masterly letter, we would publish it in these pages. We are grateful for his response.

Fr. Edmonstone wonders if we should not at some time discuss in our meetings the formation of a larger Jesuit Science Organization, with a Bulletin, though possibly otherwise informal, in order to keep Jesuits around the world in touch with their confreres in the United States and Europe who are likewise engaged in the scientific apostolate. Such groups of our men in Africa are separated at intervals of 1500 miles or more. He hopes and prays that from such discussion, something might emerge.

Father is looking forward to the day when some Jesuit anthropologist or Antarctic explorer crosses the threshold of his laboratory. The field in anthropology is ready for the harvest! *Editor.*

THE PHILOSOPHY OF MATHEMATICS

Rev. Frederick J. Adelmann, S.J.

The topic of this paper is the Philosophy of Mathematics. This is a very wide topic, and one cannot hope to do justice in so short a space to the many aspects of it. It is important to emphasize here that when one is philosophizing about mathematics one is not doing mathematics. It is one thing to do mathematics—to do what a mathematician does—and quite another to think *about* mathematics, to ask philosophic questions about mathematics. It is somewhat like philosophizing about biology or science in general; thus we have the philosophy of science or the philosophy of nature. So, strictly speaking, to talk about the philosophy of mathematics one must know both what philosophy is and what mathematics is, in the sense of what each is about, what their respective methodologies are, and the objects they are concerned with. When one mathematicizes the acts differently than when praying or going for a walk; as a matter of fact, the general theme of this paper is to try to explain this very point: namely, the differences between philosophizing and mathematicizing. And so in this limited sense the philosophy of mathematics will be discussed.

The discussion can be limited even more and perhaps made a little more interesting. Two points will be made: first, that the apparent death-blow mathematics seems to deal to certain philosophical principles is merly apparent; second, that mathematicians in general have unconsciously fallen into the prejudiced and limited methodology of the positivists and for this reason have lost their respect for metaphysics. The discussion will be limited to these two facets of the general problem of the relation of mathematics to philosophy.

Let us consider Brouwer's paradox in reference to the first point.[1] The founder of the Intuitionist School of Mathematics in brief presents the following case. We shall concern ourselves with property A in relation to any finite series, let us say from one to ten million. Now it will be true to conclude that in relation to this series there will be some number that has the property A or there will not be such a number. We plainly have an either/or situation and vindication of the logical principle of excluded middle. But if we make this same application of discoverable property A in reference to an infinite series of even numbers the matter turn out quite differently; so that we

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are forced to conclude that either there is a number in this series that has the property A or there is no such number; or the matter must be left undecided and hence the Law of Excluded Middle is dealt the anticipated death-blow. As a matter of fact, such a case is one of the basic reasons presented by certain mathematicians for disregarding the principle of contradiction in mathematics and is the foundation for the so-called three-valued-logic.

When one realizes precisely what one is doing in this case as a mathematician it will be clear that what holds for a non-existential mathematics may simultaneously be false when shifted into the area of an existential metaphysics. Strangely enough, it is this contact with the order of existence that makes the difference. If we define the *real* as that which is in constant contact with existence, our solution will be more easily recognized. A thing can be true in mathematics and false in philosophy. The double truth theory has never been condemned here. But it is the philosophy of mathematics that is able to point out the nature of mathematics and tell us what it is all about. On this point we are not interested in the Intuitionist School or the Formalistic nor in the debate about the dequantification of mathematics.

The first reply I shall make comes from Von Mises where he aptly points out: "But if we say that there is no such number that does not mean that running through the sequence of all even numbers we never hit upon a number of the property A, *because it makes no sense to speak of an examination of infinitely many numbers.*"[2]

Professor Kattsoff discussing Goedel's theorems says the same thing: "It has been shown that mathematics can never be completely formalized; that in every arithmetical system it will be possible to construct propositions which cannot be decided in that system, i.e., propositions such that it is impossible to decide whether they are true or false. This does not mean a temporary lack of proof but a permanent one, so far as the given system is concerned. This itself, it seems to me, leads to the necessity of a three-valued logic."[3]

In other words, truth or falsity as understood in connection with the Principle of Contradiction and the Law of Excluded Middle are existential. Mathematics is not necessarily limited to the existential or real order in its formalized aspects. Hence it is possible to have three-valued logics and indeterminate answers, due to the very nature of the system.

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According to Professor Martin, we have here a case similar to the one just discussed, for he analyzes Kattsoff's remarks thusly: "Unless a collection of numbers can be denumerated, or yield a law of denumeration, it cannot be taken as A or not-A but must be considered as indeterminate. Do we then have a limitation on the Law of Excluded Middle? Let us see."

"If a metaphysics is assumed which has no room for potency as well as act, an affirmative answer may follow. A pure form is act. As we have seen, it is just what it is. Something is a triangle or it isn't. Something is either A or not-A, and there is no middle ground. Now, let us suppose that mathematics, in the positive sense dealing with quantity *qua* quantity—in itself legitimate as a means only—is absolutized. Not intelligible matter but just the intelligible; not quantitative being, but just quantity. What should be mentally abstracted for the purpose of understanding becomes metaphysically real, *reified*. If, now, difficulties arise in mathematics of the kind given, then it would seem as if a three-valued logic is implied. A proposition is true, false, or indeterminable (undecidable). We are assuming, of course, that the undecidable is real and not merely a psychological matter."[4]

Although it seems to the present writer that one might go further than Dr. Martin in allowing for the dequantification of mathematics and hence including a pure axiomatic type, still he offers an answer to this difficulty similar to that which Von Mises unconsciously did. Dr. Martin is fully aware of the answer as when he indicates that the problem only arises when the mathematician *reifies* the abstract. In other words, if one considers the entities of mathematics as real in the strict existential sense of metaphysics, of course, there is a problem. The fact is that even the mathematician is aware that this is impossible, but he often talks about his entities as if they were real. In other words, he hasn't made a philosophical distinction that is necessary. When he tries to abolish a philosophical principle he is philosophizing, and he must realize this and realize in what sphere philosophy operates.

When Von Mises said above that Brouwer's infinite series is not denumerable he unconsciously emphasized the same point. When he said that "it makes no sense to speak of an examination of infinitely many numbers" he was merely saying that such a series is not real, does not exist actually in the existential order, outside of some mathe-

matician's mind. It is similar to a discussion of the points of the continuum; they are potentially infinite but not actually, i.e., really, existentially so. In metaphysics it makes a real world of difference whether the reality is act or potency. So too, metaphysically speaking, it makes a world of difference whether the entity under discussion has a link with the existential order or can roam through the labyrinthian ways of some mathematician's mind as a construct of *never-never land*. This latter area is proper to pure mathematics; it has no place in a real metaphysics.

One of the points to be emphasized here is the limitations of a true metaphysics as well as that of a correct mathematics. Metaphysics, if it is to solve any of its problems, must always retain a link with existence. If it ever loses it, it ceases to be valid. It should start with real contact with existence, and it can probe into the past and consider the future but as connected with existence—not as an isolated construct.

In reference to the second point, namely that mathematicians in general have adopted the unique method of positivism, with the result that like the positivists they have no place for metaphysics. As the deductive form of mathematics has expanded from quantitative mathematics to a dequantified type, it has grown to include within its sphere logic, semantics, analysis, and other relational forms. Consequent upon this expansion mathematics has been brought to the brink of philosophy in the sense that it is concerned with language and meanings.

However, this is precisely where we encounter the prejudice. Instead of meeting the real as real and becoming interested in the problem as metaphysical, as it should be, mathematicians have unconsciously limited themselves. Until very recently at least, mathematics has been confined in its use to the positive sciences such as physics and chemistry. More recently it has become involved in the social sciences and even in biology and psychology. In the quest for the unity of science, mathematics seems to be the *meta-system* or form; it seems to be the common unifying pattern of all the sciences.[5]

When the problem arises about evidence or a verification principle for mathematical propositions, it is always discussed in the climate only of the positive sciences. Here the only principle of verification allowed is direct or indirect observation reducible to measurability. If a thing cannot be observed, at least indirectly by looking at a chart or at coordinates or at an indicator, then there is no verification. Sensible measurement is the unique norm.

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But the interesting aspect of all this is that such a verification principle limits the object to the material. There can be no event, no fact, no experience that will have any contact with a mathematical application or principle that is not sensible in the sense that it must be observable by some sort of measurability. But it does not take much philosophical insight for one to realize that the real world on such an assumption would be limited to a material world. The only realities that are worth bothering about, that mathematics can be applied to or concerned with, would be material realities. And this not because immaterial realities have been disproved but because they have been outlawed by the method of Positivism and its verification principle. And it is this principle which most mathematicians have adopted as the uniquely valid one.

To sum up then, the first point is that, since mathematics is by its nature cut off from the existential order, it can correctly say a lot of things that simply are not really true. The second point is that if mathematics touches the existential order either as a point of departure or as place for corroboration it cannot limit its view of the real to what is material. For thus it would not allow even for the possibility of a non-material being real.

The metaphysician knows that there are non-material beings and that they are real. Now if mathematics is to open itself up to uses beyond that of mere quantity, then it must realize that those techniques of present day science that have no place for non-material realities must be cast aside as outmoded and prejudicial to true science. The mathematician must also realize that in the area of the real as real he is in the sphere of philosophy and is not merely doing mathematics. An awareness of this distinction between the two fields and a proper respect of each thinker for the other's work may bring a mutual cooperation that will do much to further peace on this planet.

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A SENSITIVE LONG PERIOD VERTICAL SEISMOGRAPH

Richard A. Miller, S.J.

Abstract. An attempt has been made to provide a sensitive long period seismograph for vertical motion, by providing a fluid support for the inertial mass. Results, thus far obtained, are promising.

Introduction. Though vertical seismometers with a long period, symmetrical zero and period reasonably independent of amplitude of swing are sufficiently developed today for many seismological problems, a new slant on the construction of such seismometers is offered, which should clarify the interpretation of certain types of seismic waves. Each person's handwriting is different and tells something of the personality of its author. Different seismic instruments write distinctively of seismic waves and each probes more deeply into certain facets of earthquake waves than others.

If, as is the case with most vertical seismometers, the inertial element is hinged about a horizontal axis, the period of such a vertical seismometer is:

$$T = 2\pi\sqrt{I/t} \tag{1}$$

where T is the period, I is the moment of inertia of the system and t is the ratio of the torque to the angle of twist.

Horizontal seismometers and vertical seismometers of a rather short period can be made quite sensitive. The difficulty with the long period vertical seismometer is that sensitivity, which is not to be confused with magnification, is often sacrificed to obtain the long period. Gravity presents the problem.

The sensitivity of a simple vertical seismograph is inversely proportional to the coefficient of restitution. A large coefficient of restitution is necessary to support a large mass against gravity. A long period requires a high ratio of mass to coefficient of restitution. It is well known that most long period vertical seismometers of the hinged suspension type, obtain a large ratio of moment of inertia to angular coefficient of restitution, by balancing one mass against another mass and leaving a small overbalancing mass on one arm of a lever. This residual mass is then supported against gravity by a small spring. The period is further lengthened by decreasing the perpendicular distance from the axis of rotation to the small supporting spring in accordance with the formula:

[93]

$$T = 2\pi\sqrt{I\,d\,1\,L/(k\,d^3\,1\,L - g\,I\,z_1\,z_2)} \qquad (2)$$

where, as before, T is the period of the seismometer, I the moment of inertia; 1 is the reduced pendulum length, i.e., the perpendicular distance between the center of oscillation and the axis; L is the length of the spring loaded and at rest; d is the distance from the axis perpendicular to the line of the small supporting spring; k is the elastic constant of the spring, viz. the coefficient of restitution; g is the acceleration of gravity and z_1 and z_2 are the lengths into which the spring is divided by the intersection of line d, the perpendicular distance from the hinge to the spring.

Special precautions are needed to make the restoring force symmetrical on opposite sides of the equilibrium point. Instability results if d is made too small.

The idea of balancing one mass against another to obtain a large moment of inertia and then the idea of supporting a small residual mass on one arm of the lever by means of a small spring—achieves a long period but at the expense of sensitivity. Electromagnetic magnification obviates some of the inconveniences of sensitivity loss, but a study of seismic records both at Fordham University, New York City, and at the Manila Observatory in the Philippines, shows many impulses are lost on the vertical records which appear on the horizontal records.

A motion of the supporting frame of the inertial elements, let us say upwards, causes the two balancing masses which have been accelerated upwards, to resist by pushing downwards. Each mass counteracts the other, except for a small residual mass on one side, which provides the actual inertial staying force. Relative to the supporting frame, only this small inertial element provides driving force for the motion which will eventually be amplified onto the seismic record. Both in a direct recording and in an electromagnetic seismometer, the important mass is the mass which is accelerated relative to the supports of the inertial members by the motion of the earth. Balancing masses are not so accelerated. To increase the sensitivity, it is desirable to increase the residual mass on one arm of the lever without shortening the period of the seismometer.

Buoyant Support As A Solution. Archimedes principle provides a way of cancelling gravity forces effectively, while at the same time preserving a large mass, a long period and the high sensitivity dependent on a high ratio of mass to coefficient of restitution. To the
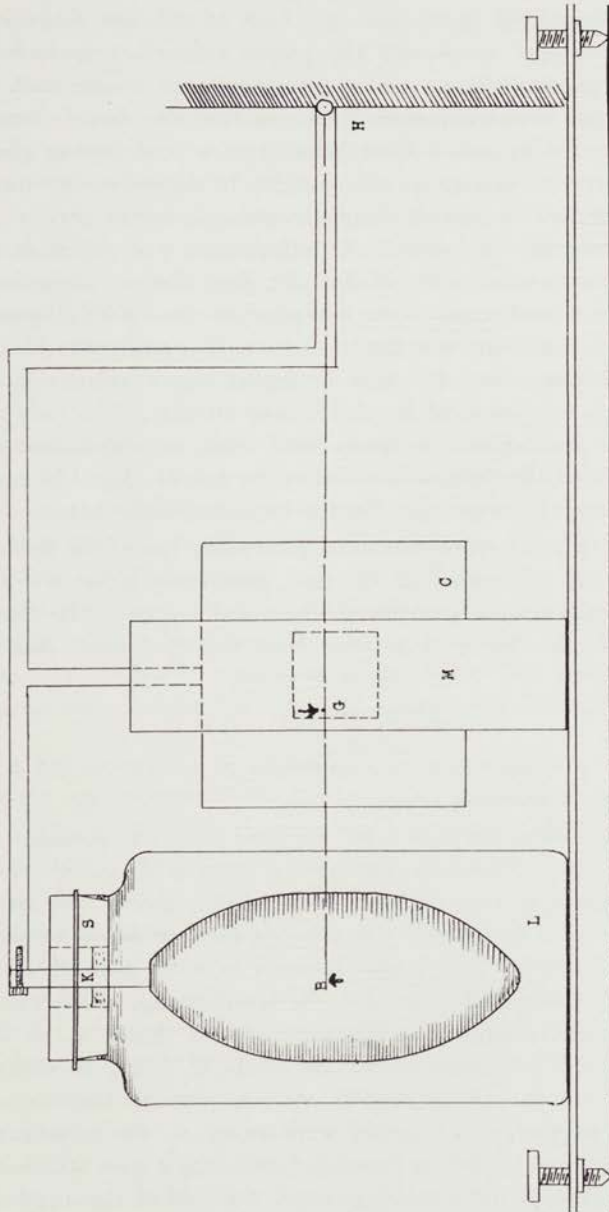
Sensitive Long Period Vertical Seismograph (Electromagnetic)
(B) Buoyant Force; (C) Coil; (G) Gravity Center; (H) Hinges; (K) Stem; (S) Stopper; (L) Liquid;
Displacement of Stem From Equilibrium Position Provides Restoring Force.

inertial element, the author, in an experimental model, attached a buoyant element, rigid, light, fluid-tight body of sufficient dimensions, and properly placed to provide the proper counteracting force to the force of gravity. Two types of buoyant elements were used. In one, the upward force was just insufficient to float the inertial element, the extra upward balancing force came from a small spring placed so that its force was exerted perpendicularly. In the other, the upward force was sufficient to provide complete counteraction of gravity, i.e. the element floated. A uniform cylindrical stem was placed on the top of this buoyant element, so that the fluid line or water level, when water was used, came to the mid-point of the snorkel-like stem. As this buoyant element was displaced from its equilibrium position either deeper down into the fluid or higher up, a greater or less buoyant force was produced by the floating element. The stem was made regular and various diameters were used, in accordance with the magnitude of the coefficient of restitution desired. Just like a spar buoy, this buoyant element then has a natural period of vibration.

Assume that the cylindrical stem, protruding out of the fluid, be of radius, r; let the density of the fluid, practically either water or kerosene or mercury, be represented by ρ: and represent the change of vertical position by $\pm \Delta z$, away from the equilibrium position. Then,

$$\Delta F = \pi r^2 \, \rho \Delta z, \qquad (3)$$

where $-\pi \, r^2 \, \rho$ is equivalent to a coefficient of restitution and ΔF is the increment of restoring force.

Design. Many variations on the basic idea are possible: and several were tried. The most satisfactory setup is to use the usual hinged suspension of a vertical instrument with a boom. The axis of swing, of course, is horizontal. The buoyant element should be placed at the end of a rather long boom. In order to avoid as much of the friction drag of the fluid as possible, the boom should, in the case of the ordinary electromagnetic seismometer, be so shaped as to keep the magnet, coil and boom out of the fluid. It would be desirable to streamline the buoyant element for vertical motion. Coefficient of restitution is provided for, either by weak springs, or the coefficient of restitution may be supplied, as mentioned above, by a stem attached to the buoyant element and protruding above the level of the supporting fluid—or by both a stem and a small spring.

The restoring force should be linear. t of equation (1) should be reasonably independent of the amplitude of swing. With both a small spring and with a snorkel-like tube, linearity would be provided for. The spring would at least offer no more difficulty on that score than the usual spring suspension. In the case of the thin snorkel-like tube, its restoring force would depart from linearity with the amplitude of the swing because it would incline more from the vertical at the top and the bottom of the swing. Here, the departure from linearity would be as the tangent of a small angle departs from the radian measurement of the small angle itself. For a one degree swing, this is one-one hundred thousandth—a negligible amount.

The buoyancy torque and the gravitational torque act in opposite directions. Not only must they be balanced at the equilibrium position, but also, except for the slight linear restitution force, they must be balanced at all positions of the swing. Of course, any point on the boom travels in the arc of a circle. Buoyancy effect on the buoyant element acts always straight upwards, and gravity force acts always straight downwards. The perpendicular distance, or lever arm, from the line of the buoyancy force as well as from the line of the gravitational force to the pivotal axis, will noticeably change with a large swing. Therefore the effective point of application of the buoyancy force and the center of gravity of the system should lie on the same straight line from the pivotal axis. It is necessary that:

$$dL_b/d\theta = dL_g/d\theta \tag{4}$$

namely, the change of the buoyancy torque, (except again for the linear restitution force) must equal the change of the gravitational torque, with respect to the change of the angle of swing. This holds except for the thin tube projecting out of the fluid which is buoyed up more or less as it is deeper into or higher out of the fluid. As usual, the whole seismometer should be sealed off from air currents.

Because of the long period, extra precautions had to be taken to provide sufficient electromagnetic damping. Aluminum walls, instead of the usual plastic walls, were used to contain the windings of the coil.

A source of trouble, when such a seismograph is initially set into operation, is the change of the buoyancy effect because of the changing density of the fluid with changes of temperature. The thermostatic control usual in a seismic vault, or the even temperature consequent upon having the vault sufficiently deep in the ground, are sufficient,

but it is desirable to have a few very small weights, which can be attached to the boom, in order to keep the buoyant element at the proper depth in the fluid and the coil properly positioned in the magnetic field.

There was no difficulty experienced by the author with convection currents in the buoyant fluid. They are so slow as to have no noticeable effect on the workings of the instrument. Surface waves are made negligible by shaping the containing vessel for the fluid, so as to allow very little free surface.

Results. A 4-second vertical seismograph which employed the above principles and which the author had in operation at Fordham University, through the encouragement of Rev. Joseph Lynch, S.J., provided some interesting records. It responded to regular earthquakes, somewhat as the long period horizontal seismograph does, yet it had additional wave forms, which records from the other seismographs did not show. These were waves of considerable amplitude and short duration. They were, to a great part, traced to traffic on Fordham Road which is at its closest, a few hundred yards from the seismic vault. Holiday traffic was much more noticeable than on any other record from the other seismographs. The author, by timing the intervals between the red and green lights of the signal lights at various intersections on Fordham Road, came to the conclusion that the large amplitude, short duration pips on the records originated with the sudden stops which the huge trucks which use Fordham Road, made when the shifting of a signal light forced them to a stop. Some of these impulses indicated a compression—others, a rarefaction as the first disturbance to reach the seismometer.

Such a seismometer would seem to be useful to detect earth motions caused by mobile equipment, such as, perhaps, analysis of the effect of heavy vehicles on various types of roads.

A simple diagram of such a workable seismograph is shown. The idea can be extended to a direct recording vertical seismograph.

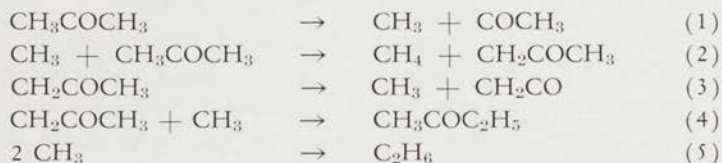# PHOTOCHEMICAL STUDY OF ELEMENTARY REACTIONS*

Part I. General Principles

CHARLES L. CURRIE, S.J.

Much of the work in Chemical Kinetics today seeks to unravel the individual reaction steps by which many chemical changes occur. It has become increasingly evident that the formation of final products from initial reactants takes place by one or more relatively simple steps. These individual steps are termed "elementary reactions," and usually involve atoms or radicals. We may illustrate this with the mechanism proposed[1] for the decomposition of acetone:

$$CH_3COCH_3 \rightarrow CH_3 + COCH_3 \qquad (1)$$
$$CH_3 + CH_3COCH_3 \rightarrow CH_4 + CH_2COCH_3 \qquad (2)$$
$$CH_2COCH_3 \rightarrow CH_3 + CH_2CO \qquad (3)$$
$$CH_2COCH_3 + CH_3 \rightarrow CH_3COC_2H_5 \qquad (4)$$
$$2 CH_3 \rightarrow C_2H_6 \qquad (5)$$

We shall discuss this mechanism in greater detail later, and are using it here only as an example of how elementary reactions are proposed to explain an over-all reaction.

Photochemical techniques are important in the study of these elementary reactions since the atoms and radicals involved may be produced at or near room temperature, where many complicating side reactions are too slow to have an appreciable effect. Also, while thermal reactions employ what might be called a *shotgun* technique in which the energy necessary to break bonds and so cause reaction is distributed over a wide range, photochemical reactions use a *rifle* that delivers quanta of known energy hv. This permits more precise quantitative studies. Energy is supplied directly to the reactants in photolysis, indirectly in photosensitization.

In photolysis[2] absorption of light leads directly to the formation of an excited molecule, which by decomposition or reaction gives rise to products. They may be the final products or atoms and radicals, in which case secondary reactions of the atoms and radicals follow.

Most photolyses are carried out with light of wave length from 3400 to 2500 Å. Hence, the absorbed quanta introduce into most molecules at least 10 kcal. more than necessary to break the weakest bond. The radicals formed have 10 or more kcal. of excess energy distributed among internal or translational degrees of freedom. If internal, the radical will have a tendency toward unimolecular decomposition, but if translational, it will have a tendency to react bimolecularly with ordinary molecules. The former case, that of the *hot* radical, is less common, but is a complication to be considered in every photolysis.[3] *Hot* radicals can often be assumed to be present if the reaction is slowed down by the addition of an inert gas, which removes some of the excess internal energy by collisions.

Many molecules cannot be decomposed conveniently by direct photolysis, but can by photosensitization.[4] For a photochemical reaction to occur, the light must be absorbed (i.e., the molecule must have an appropriate allowed transition) and the energy of the incident light, when converted into vibrational energy, must be large enough to break the bond. But, for many substances the first transition corresponding to sufficient vibrational energy is in an inconvenient part of the spectrum. Hydrogen and the simple hydrocarbons, for example, do not absorb appreciably until below 2000 Å, i.e., in the experimentally difficult vacuum ultra-violet region. Yet this transition corresponds to a vibrational energy much greater than necessary for bond dissociation. The problem, then, is to get the energy into the molecule in an easier way.

In the process of photosensitization a substance is chosen to absorb light of a frequency which will be in a convenient part of the spectrum, and of an energy slightly greater that the dissociation energy of the bond in question. This substance will, on collision, transfer its energy to the hydrogen or hydrocarbon molecule and cause dissociation. Mercury vapor is the substance usually chosen, although cadmium, zinc, and sodium can also be used.

The mercury atom in the ground 6 $^1S_0$ state absorbs light of 2537 Å, and is raised to the excited 6 $^3P_1$ state. If it makes the appropriate collision with a foreign gas molecule, it will be quenched i.e., lose its energy without an optical transition. In the simplest cases, the atom can be quenched to the metastable 6 $^3P_0$ state, in which case only 5 kcal. can be transferred to the foreign gas molecule

(an energy too small for chemical reaction), or to the 6 $^1S_0$ state, thereby transferring 112 kcal. to the molecule of the foreign gas:

$$Hg\ (6\ ^3P_1) + RH \rightarrow Hg\ (6\ ^1S_0) + RH^*$$

This energy is sufficient to break most chemical bonds and RH* may decompose if the electronic energy is efficiently converted to vibrational energy:

$$RH^* \rightarrow R + H$$

Thus far we have two methods whereby the atoms and radicals involved in elementary reactions are conveniently produced, and now we may consider how these reactions are studied once they have been initiated.

In the ordinary case of stable substances k, the rate constant, is usually found directly by knowing all the variables save k in the expression, rate $= k\ [A]\ [B]$. With radicals, however, it is almost impossible to determine $[R]$, and so indirect methods are necessary to find k. The rate constant once found is used to determine the activation energy E and the frequency factor A in the Arrhenius equation: $k = A\ e^{-E/RT}$. By plotting log k vs. $1/T$, E is given as the slope, and A as the intercept, and so k is always sought as a function of temperature.

Six types of elementary reactions can be considered,[5] but to illustrate the general way the data are treated we may select one of these, viz., the abstraction reaction of the type:

$$CH_3 + RH \rightarrow CH_4 + R$$
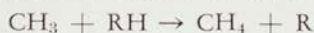
where the methyl radical has abstracted a hydrogen atom from the hydrocarbon to produce a different molecule and radical. There is no generally applicable method for determining $[CH_3]$, and so an indirect method for finding the rate constant is necessary.

Consider the photolysis of acetone at high temperatures,[6] where the mechanism previously cited holds. The rate of production of methane, R_{CH_4} is given by:

$$R_{CH_4} = k_2\ [CH_3]\ [CH_3COCH_3]$$

and that of ethane, $R_{C_2H_6}$ is given by:

$$R_{C_2H_6} = k_5\ [CH_3]^2$$

Thus:

$$k_2/k_5^{1/2} = \frac{R_{CH_4}}{R_{C_2H_6}^{1/2}\ [CH_3COCH_3]}$$

[101]

All the quantities on the right hand side are found experimentally, so that $k_2/k_5^{1/2}$ can be found at any temperature.

When acetone is photolyzed in the presence of a substrate, RH, methane is also produced by the reaction:

$$CH_3 + RH \rightarrow CH_4 + R \tag{6}$$

In this case:

$$R_{CH_4} = k_2 \, [CH_3] \, [CH_3COCH_3] + k_6 \, [CH_3] \, [RH]$$

$$R_{C_2H_6} = k_5 \, [CH_3]^2$$

$$\frac{R_{CH_4}}{R_{C_2H_6}^{1/2}} = \frac{k_2}{k_5^{1/2}} \, [CH_3COCH_3] + \frac{k_6[RH]}{k_5^{1/2}}$$

The first term on the right is known at any temperature from the data on the photolysis of acetone alone, and thus, knowing [RH], $k_6/k_5^{1/2}$ at any temperature can be found. Using Arrhenius' equation, one can also determine $E_6 - \frac{1}{2}E_5$ and $A_6/A_5^{1/2}$. The rates of elementary reactions involved in chain mechanisms are independent of the way in which the particular atoms or radicals arise. Well-established values of the k's, E's, and A's here, for example, have universal validity, and thus can be used in working out other mechanisms. This is one of the main reasons for the interest of the kineticist in elementary reactions.

We have illustrated with acetone how one produces photolytically the radicals involved in elementary reactions, and how one might, in a typical way, study these reactions once they have been initiated. The next paper will consider in much greater detail, for the case of dimethyl ether, the photosensitized production of radicals and the disentangling of the subsequent elementary reactions.

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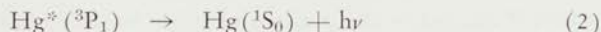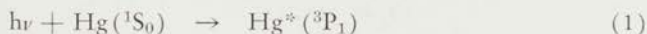5. Steacie, E. W. R., Atomic and Free Radical Reactions.
6. Ibid.

Part II. Photosensitized Decomposition of Dimethyl Ether

ERNEST G. SPITTLER, S.J.

I.   In the previous paper, it was shown that photosensitization can be used to study elementary reactions. In the present paper, the method will be applied to certain elementary reactions occurring in the photosensitized decomposition of dimethyl ether.

The mechanism proposed for the decomposition process by Marcus, Darwent and Steacie,[1] includes the following reactions. They may be divided into three categories; initial absorption and primary reactions following absorption, low temperature secondary reactions, and high temperature secondary reactions.

A.   Absorption and primary reactions

$$h\nu + Hg(^1S_0) \quad \rightarrow \quad Hg^*(^3P_1) \tag{1}$$

$$Hg^*(^3P_1) \quad \rightarrow \quad Hg(^1S_0) + h\nu \tag{2}$$

$$Hg^*(^3P_1) + CH_3OCH_3 \quad \rightarrow \quad Hg(^1S_0) + H + CH_3OCH_2 \tag{3}$$

B.   Low temperature secondary reactions

$$H + CH_3OCH_3 \quad \rightarrow \quad H_2 + CH_3OCH_2 \tag{4}$$

$$2\,CH_3OCH_2 \quad \rightarrow \quad (CH_3OCH_2)_2 \tag{5}$$

C.   High temperature secondary reactions

$$CH_3OCH_2 \quad \rightarrow \quad CH_3 + HCHO \tag{6}$$

$$CH_3 + CH_3OCH_3 \quad \rightarrow \quad CH_4 + CH_3OCH_2 \tag{7}$$

$$HCHO \quad \rightarrow \quad H_2 + CO \tag{8}$$

$$2\,CH_3 \quad \rightarrow \quad C_2H_6 \tag{9}$$
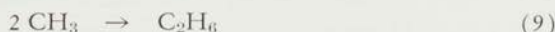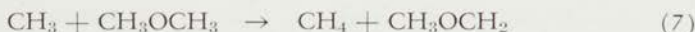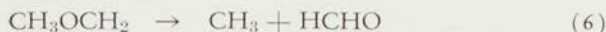
II.   From a consideration of the above mechanism it is evident that there are two sets of competing reactions taking place in the system. One involves methyl radicals, and the other involves methoxymethyl radicals. The methoxymethyl reactions are: recombination to give dimethoxyethane, (reaction 5); and unimolecular decomposition to give formaldehyde and a chain-propagating methyl radical, (reaction 6). The methyl reactions are: recombination to give ethane, (reaction 9); and bimolecular attack of dimethyl ether by methyl radicals to give methane and a methoxymethyl radical, (reaction 7).

The above reactions may be followed by the rates of production of dimethoxyethane, formaldehyde, methane and ethane respectively. The formaldehyde rate, however, must be corrected by adding to it the rate of carbon monoxide production from (reaction 8), which removes formaldehyde from the system.

III. The rate equations for the methyl radical reactions may be written as follows:

$$d/dt \ [C_2H_6] \ = \ k_9 \ [CH_3]^2 \tag{1}$$

$$d/dt \ [CH_4] \ = \ k_7 \ [CH_3] \ [CH_3OCH_3] \tag{2}$$

Combining these two equations we obtain the following result:

$$R_1 \ = \ \frac{d/dt \ [CH_4]}{(d/dt \ [C_2H_6])^{1/2}} \ = \ P \ k_7/k_9^{1/2} \tag{3}$$

where P designates the pressure of ether in the system, and

$$R_1/P \ = \ k_7/k_9^{1/2} \tag{4}$$

But

$$k_7 \ = \ A_7 \ e^{-E_7/RT}$$

and

$$k_9 \ = \ A_9 \ e^{-E_9/RT}$$

where the frequency factors are given by the A terms.

Taking the logarithm of R_1/P we obtain the following:

$$\log \ (R_1/P) \ = \ \log \ \left\{ \frac{A_7 e^{-E_7/RT}}{A_9^{1/2} e^{-1/2 E_9/RT}} \right\} \tag{5}$$

$$= \ \log \ (A_7/A_9^{1/2}) \ - \ (E_7 \ - \ 1/2 E_9)/RT \tag{6}$$

If we plot the logarithm of R_1/P against $1/T$, we find that the intercept is equal to the logarithm of $A_7/A_9^{1/2}$, and the slope is equal to $-(E_7 \ - \ 1/2 E_9)/R$. Most radical recombination reactions have very low activation energies. Hence, if we assume that E_9 is practically zero, the slope is essentially equal to $- R/(E_7)$. From which E_7 may easily be found.

IV. Similarly, the rate equations for the methoxymethyl reactions may be derived:

$$\log R_2 = \log \ (A_6/A_5^{1/2}) \ - \ (E_6 \ - \ 1/2 E_5)/RT$$

Again, a plot of logarithm of R_2 against $1/T$ should give an intercept equal to the logarithm of $A_6/A_5^{1/2}$, and a slope equal to $-(E_6 - \frac{1}{2}E_5)/R$. Assuming that E_5 is practically zero, E_6 is given by $-R$ times the slope. Also, if any one of the two pairs of frequency factors is known independently from another source, the other member of the pair may be found from the value of the intercept. Marcus, Darwent and Steacie found approximate values for the above activation energies of 10 ± 2 kcal. for E_7, and about 19 ± 2 kcal. for E_6.[2] Values for E_6 were also found, using acetone as the source of methyl radicals, and also using dimethyl mercury as the radical source. They are 9.5 ± 0.2 kcal. for the acetone source; and 8.4 ± 1.5 kcal. for the dimethyl mercury source.[3] Values for the logarithm of A_6 center about the quantity: 11.5 ± 0.4.

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INTERLINGUA—INTERNATIONAL COMMUNICATION OF SCIENCE

Rev. J. Franklin Ewing, S.J.

Last July, when I received my copy of *Science*, I thought the editors had let some *typos* get by them. On the cover, an article was entitled: *Communication in le Scientia.*[1]

I turned to this article and discovered two things: (1) I read the article without any difficulty; and (2) it was in Interlingua. On the spot, I became an advocate of this universal scientific language.

The editorial in the same issue of *Science*[2] made two very important points about this universal scientific language, to which I add my own comments.

It is Natural. Anyone who can read any western European language can read Interlingua at sight. (You can verify this statement by the samples in section 4 of this note.) "It is based on the words and grammar (simplified and regularized) of the predominant

European languages; it can be considered a sort of basic, average language (primarily for reading), common to most of the reading world."

Interlingua is *natural* in contradistinction to a constructed language, like Esperanto. It is composed of simplified elements of on-going western European languages.

Interlingua is *natural* as opposed to a return to Latin. Quite apart from our inability to turn the clock back, the fact remains that Latin, as an inflected language, is more primitive (and difficult) than such an uninflected language as English. Interlingua is not inflected.

Interlingua is a Going Concern. After considerable research, Interlingua has been taken up by editors and international conferences and a new Division of Science Service. "Since 1953 it has come into use for publication of summaries in seventeen medical journals and has served as the only secondary language in the programs of seven international medical congresses. This practical demonstration, largely in the medical field, paves the way for other utilizations." There are dictionaries and grammars available and one university (New York U.) offers a course on Interlingua in its Division of General Education.

Where to Apply. The Interlingua Division of Science Service, 80 E. 11th St., New York 3, N. Y., is only too happy to send you all sorts of literature.

We should recommend Interlingua summaries to the editors of the various scientific journals of our various fields.

Examples. Perhaps the best argument for the use of Interlingua is to set forth several examples.

In the issue of *Science* referred to previously Forrest F. Cleveland discusses the problems of Russian translation, according to the three alternatives given by O'Dette in an earlier issue of *Science*.[3] Large scale translations; or publication in an international language; or more emphasis on language instruction: these are the three. Cleveland says in part:

"Le melior del tertie alternativas pare clarmente esser le publication de omne resultatos scientific in un singule lingua international, preferabilemente un que ha un grammatica multo simple e un que esserea legibile practicamente a prime vista per alicun scientista. Si omne le resultatos scientific esseva assi publicate, le scientista tunc

poterea realmente maestrar iste un lingua sin un grande perdita de tempore. Ille haberea tunc un accesso personal e immediate al ideas e informationes que appare in le litteratura scientific del mundo.

Isto esserea si multo minus costose in tempore e moneta, e si multo plus efficace in le dissemination de informationes scientific, que illo es clarmente un fin grandemente a esser desirate. Le avantiamento de scientia esserea accrescite tremendemente si iste objectivo esserea attingite."

For good measure, here is an item from *Scientia International* (Edition in Interlingua de Science News Letter),[4] on an anthropological topic:

"Quando 104 negros e 526 blancos recipeva, pro fines therapeutic antisyphilitic, inoculationes de *Plasmodium vivax*, le parasito que causa benigne malaria tertian, il resultava que le sanguine del subjectos esseva inficite in 96, 2 pro cento del blancos e in solo 23, 1 pro cento del negros. Iste resistentia del negros esseva etiam characteristic de individuos ab regiones libere de malaria. Le resistentia se manteneva etiam in experimentos con racias del parasito que esseva novemente importate ab altere paises."

While this language should be particularly easy for us, with our large background in Latin, it should be quite intelligible to the scientist who has ever studied one occidental language—and this includes practically all.

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ERRATA

Bibliography of Jesuit Publications in Chemistry, III, item no. 235, vol. 36 (2), p. 62, Jan. 1959, should be deleted. It mistakes Dr. E. E. Salpeter of Cornell University with Father E. E. Salpeter of the Vatican Observatory. Further, in items no. 63 and 64, the Chemical Abstracts years are given erroneously. These items appear in vol. 34 (2), pp. 75 & 76 resp., Feb. 1957. In no. 63, the CA year should read 1937 instead of 1947; and in no. 64, 1938 instead of 1948. Editor is grateful to those who called these errors to his attention. Other errata found in the first instalment of this contribution have already been picked up by way of footnote to the second instalment.

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Rev. B. A. Fiekers, S.J.

Monographs on lecture demonstrations in chemistry include the following titles:

1. P. Arthur, Lecture Demonstrations in General Chemistry, 1st ed., McGraw-Hill, New York, 1939, 455 pp.
2. F. G. Benedict, Chemical Lecture Experiments, MacMillan, New York, 1925, 436 pp.
3. H. P. Davison, A Collection of Chemical Lecture Experiments, Chemical Catalog Co., Inc., New York, 1926, 139 pp.
4. G. Fowles, Lecture Experiments in Chemistry, Blakiston, Philadelphia, 1939, 564 pp.
5. E. J. Hartung, The Screen Projection of Chemical Experiments, University Press, Melbourne, Australia, 1953, 291 pp.
6. H. Rheinboldt, *Chemische Unterrichtsversuche*, 2nd ed., Steinkopff, Dresden, 1948, 352 pp.
7. H. S. van Klooster, Lecture and Laboratory Experiments in Physical Chemistry, 2nd ed., Chemical Publishing Co., Easton, Pa., 1925, 274 pp.
8. F. T. Weisbruch (S.M.), Lecture Demonstration Experiments for High School Chemistry, 1st ed., Educational Publishers, Inc., St. Louis, 1951, 333 pp.

Many standard textbooks contain special sections on lecture demonstrations. The following titles are cited as examples:

9. P. R. Frey, College Chemistry, 2nd ed., Prentice-Hall, Inc., Edgewood Cliffs, N. J., 1958. This textbook contains sections on lecture demonstrations at the ends of the chapters.
10. M. C. Sneed, J. L. Maynard and R. C. Brasted, General College Chemistry, 2nd ed., D. Van Nostrand Co., Inc., New York, 1954. This textbook contains a section entitled: Some Selected Lecture Demonstrations. Pp. 657-676.

The following books are valuable additions to the repertoire of the demonstrator:

11. K. M. Swezey, After-Dinner Science, McGraw-Hill Book Co., Inc., New York, 1948, 182 pp.
12. K. M. Swezey, Chemistry Magic, ibid., 1956, 180 pp.
13. K. M. Swezey, Science Magic, ibid., 1952, 182 pp.

Booklets on this general topic and on certain specialized topics include items 14 and 15.

14. A. P. Burrus, Demonstrations in Science, Texaco Research Center, The Texas Co., Beacon, N. Y., 1958, 32 pp., gratis.

15. S. Schenberg, editor, Laboratory Experiments with Radioisotopes for High School Science Demonstrations, USAEC, Superintendent of Documents, Washington 25, D. C., 1958, 59 pp.

16. Indexes in the educational periodical literature may be consulted, notably the Journal of Chemical Education in its 25-year Cumulative Index, 1924-1949, and subsequent annual indexes to date; School Science and Mathematics; the School Science Review (British); *Zeitschrift für den physikalischen u. chemischen Unterricht,* substantial runs at Brown University and at Weston College; Chemistry; and older serials such as the Chemistry Leaflet and the Science Leaflet.

17. Tested Demonstrations in General Chemistry, compiled by H. N. Alyea, Journal of Chemical Education, Easton, Pa., reprinted from 1955 and 1956 volumes of the Journal, $1.50. This feature is being continued and sheets appear monthly in the advertizing section of the Journal.

18. Demonstration Abstracts, by H. N. Alyea, prepared from the Journal of Chemical Education, 1924-1956, appear monthly in the advertizing section of the Journal.

19. The Welch Physics and Chemistry Digest, W. M. Welch Scientific Co., Vol. I, no. 1, Oct. 1950 to Vol. IX, no. 1, Nov. 1958 and on, issued tri-monthly during the academic year. This serial contains many abstracts from foregoing periodical literature.

20. Instruction leaflets and booklets from apparatus manufacturers should not be overlooked; notably the booklet that comes with Tracerlab's Demonstration Geiger Counter, Cloud Chamber literature and the like.

21. Manufacturers and distributors of chemicals, papers, catalysts and the like sometimes supply references and/or other information on demonstrations. Examples are: Chemiluminescence by the Varniton Co., 416 No. Varney St., Burbank, Cal.; Oxycat for burning gas without flame, Oxycatalyst, Inc., Wayne, Pa.

22. Corrosion in Action, a book published by the International Nickel Co., 67 Wall St., New York 5, N. Y., which contains essentially the content of the soundtrack of a film by the same title, also contains an appendix of recipes for the numerous demonstrations appearing in the film.

23. The NEACT News letter often carries resumés of lecture demonstrations carried out in regular meetings and in the Summer Conference programs of the New England Association of Chemistry Teachers.

24. Domestic literature includes THIS BULLETIN and the Hormone, both from the College of the Holy Cross. Indexed.

25. Science Demonstrations and Lecture Experiments, Imperial Oil Limited, Production, Research and Technical Service Dept., Calgary, Alberta, Canada, 1958, 44 pp., gratis.

News Items

Boston College. Sigma Xi heard Lancelot Law Whyte, noted British author, philosopher of science, and organizer of the Jugoslavian National Boscovich Festival, lecture on Ruggiero Giuseppe Boscovich, S.J., 1711-1787, before a joint meeting of many campus societies on Dec. 11, 1958. On March 19, 1959, Sanborn C. Brown of the Department of Physics, Mass. Inst. Tech. will be the Sigma Xi lecturer on Benjamin Thompson, Count Rumford. Physics Colloquia at the College for the Fall Semester included Prof. Joseph H. Chen of Boston College on Ultrasonic Absorption in Butanes, Nov. 4, 1958; Dr. Giovanni Lanza, of Northeastern University on Magnetic Bottles, Nov. 18, 1958; and Fr. W. G. Guindon, Chairman of the Department, on the Air-Core Betatron. Fr. S. J. Bezuszka, Chairman of the Department of Mathematics, announced last Fall an NSF grant of $200,000 for the Institute of Modern Mathematics in conjunction with the School of Education's activities in the modernization of the teaching of mathematics in elementary and secondary schools. In August 1958 the Science Branch of the Boston College Library published a 42-page mimeographed list of its serials holdings in the field of Science. The Science Library is housed in the ca. 30 × 70 foot room in Devlin (Science) Hall on the first floor overlooking the northern promenade. This room had served successively as a museum, for classrooms and as an organic chemistry laboratory. It seems to have found its true function. The library features full time attendants, stack carrells for professors and graduate students in addition to its many valuable collections in science. It contains 10,104 volumes and subscribes to more than 365 journals.

Professor A. J. deBethune of the Chemistry Department is scheduled for a paper before the Electrochemical Colloquium of the Departments of Metallurgy and Chemistry at Mass. Inst. Tech. on Apr. 22, 1959. His topic is Temperature Coefficients of Electrode Potentials.

The Albertus Magnus Guild will meet at Alumni Hall on Commonwealth Ave. near Boston College at 4:30 P.M. on Tuesday April 7, 1959. This meeting is being held in conjunction with the 135th

meeting of the American Chemical Society in Boston that week. It will be recalled that the Guild was founded there earlier this decade. Prof. Robert O'Malley of the Chemistry Department is in charge.

The passing of Prof. John W. Shork, associate professor of physics at Boston College, on Nov. 21, 1958, brought to a close a long period of loyal service to the work of the Society that should not go unmentioned. At about the time of the outbreak of World War I he came to Boston from Kaunas, Lithuania, where he had attended our Jesuit school. At first he was employed in the physics laboratory at the old Boston College on James St. under Fr. Daniel Lynch. He soon found himself with the AEF in a branch that we would now call the OSS in which his mastery of many Baltic and other languages was put to good use. On discharge from the service he returned to Fr. Lynch and Boston College as a laboratory technician in physics. In the late twenties he earned his Ph.B. degree there, followed by the M.S. in physics in the early thirties. While at Boston College he held many consultancies in the electronic industry that was rapidly growing in that area in later years. May his soul rest in peace.

The Department of Geology was started at Boston College in September 1958, chairmanned by Fr. James W. Skehan, formerly of the Weston Observatory. Fr. Skehan was elected to the presidency of the Boston Geological Society.

Canisius College. Dr. Miller of the Physics Department presented a display at the High School Science Day. Experiments developed and used in the electronics laboratory were shown.

Fordham University. The January issue of *Fordham Life* contains an interesting article on the life and work of Dr. Victor F. Hess, Professor Emeritus, Nobel Prize winner for cosmic ray research. When the University of Innsbruck conferred its honorary degree on Dr. Hess last year this was the fourth honorary degree that he received. Dr. Hess' latest honor was the presentation of the Fordham *Insignis* medal to him by Fr. McGinley. The University has received a grant of $95,000 from the National Science Foundation to support a Summer Institute for High School Teachers of Mathematics and Physics during 1959. An open symposium tracing the 100-year history of the theory of evolution and its influence on American society was held on December 3, 1958 at the University. The program, entitled *A Century of Evolution*, presented talks by Fr. Ewing and Fr. Hopkins.

Ricerche Astronomiche, 6 (6), 109-149 (1958), carries the article: *Six Cepheid Variables in the Cygnus Cloud, VV 45-50*, co-authored by Fr. Walter J. Miller.

The Stethoscope, publication from Fordham's Laennec Conference, published its Winter issue for 1959, vol. 7, no. 1. In the choice and treatment of topics it has established good equilibrium with the pre-medical students' interests and ability.

Fr. Frederick L. Canavan spent the summer of 1958 as a research associate at the Radiation Laboratory of the University of California.

On Jan. 9, 1959 Fordham suffered the loss by fire of its chemical laboratory annex building, a one story war surplus structure of frame construction. The loss of building and equipment was estimated at about one-quarter million dollars. But for two injuries, there were no casualties. New York University and St. Peter's College have offered their facilities to the 45 pharmacy students, 15 graduate students and five teachers of chemistry so that they can resume their work with minimum time losses. The main chemistry building on the Fordham campus was not affected.

Georgetown University. A short-period vertical Wilson-Lamison seismograph has been installed in the vault under the Maguire Building. Strong earthquakes are reported to government and newspaper services. The University has been awarded $27,600 from the National Science Foundation to conduct a summer institute for secondary school teachers of methematics. A second three-year grant of $105,000 was made by the John A. Hartford Foundation to be used for research at the University Medical Center. The Observatory has acquired a $17,500 Telereader for studies of faint lines in the solar spectrum. The Telereader can be used for measuring positions of star places on a photographic plate.

College of the Holy Cross, Department of Chemistry. Publication activities include: no. 90, A. VanHook (staff), W. F. Radle (physics staff), J. E. Bujake (MS '55), and J. J. Casazza (Scranton '54, H. C. MS '55), *Crystallization of Sucrose with Sonic Waves*, J. Am. Soc. Sugar Beet Technologists, 9 (7), 590-5 (1957), done under grant from U. S. Dept. Agriculture, Albany, Cal; no. 91, A. VanHook, *Nucleation in Saturated Sugar Solutions*, Chapt. 3, pp. 113-148, Vol. II, *The Principles of Sugar Technology*, Elsevier, New York, 1959; no. 92, A. VanHook, *Kinetics of Crystallization, Growth of Crystals*, Chapt. IV, pp. 149-183, ibid.; no. 93, A. VanHook, *Sulla*

forma dei cristalli di saccarosio, L'Industria Saccarifera Italiana, nos. 11 & 12, Nov.-Dec., 1958. Further, the article by Francis P. Fehlner, '56, on *Growing Crystals, a Survey of Laboratory Methods,* excerpted from his senior thesis and appearing in the Journal of Chemical Education, *33,* 449 (1956), has been selected as one of about forty-eight articles to be reprinted in *Selected Readings in General Chemistry,* Chemical Education Publishing Co., 20th & Northampton Sts., Easton, Penna., 128 pp., $2.00, Editors: W. F. Kieffer and R. K. Fitzgerel. Fehlner is now a graduate student at R. P. I. Again, Dr. F. O. Rice, H. C. hon. D.Sc., 1958, has published *Free Radicals, Collected Papers of F. O. Rice,* Catholic University of America Press, 620 Michigan Ave., NE, Washington, D. C., 1958. Undoubtedly a number of Jesuit Chemistry Alumni appear in this volume as co-workers, Dr. E. L. Rodowskas, Loyola College, Baltimore, 31, H. C. MS '32, for example, and notably Fr. Robert E. Varnerin of this Association. A book review on *Padre Pio,* by Nesta de Robeck, Bruce, Milwaukee, 133 pp. appears from the pen of Fr. J. A. Martus (staff) in the Jan. 1959 *Catholic Free Press* (Diocese of Worcester) *Book Supplement.*

Items on alumni include the meeting of the Crusader Chemist Alumni at the 135th National Meeting of the American Chemical Society in Boston. Luncheon is scheduled for Wednesday, April 8, 1959. Location is still to be announced. At that meeting Fr. Fiekers expects to report to the Chemical Education Committee and/or Council the results of a recent national survey conducted by a sub-committee of the Council under his chairmanship on the feasibility of Teacher Affiliate Classification of Association with the American Chemical Society. An Associated Press release of Feb. 17, 1959 with the local title, *Cancer Specialist Called in for Dulles,* provides the alumni item of broad interest, that Dr. C. Gordon Zubrod, H. C. '36, Clinical Director of the National Cancer Institute of the NIH is the specialist.

New apparatus in the department includes a four-foot single column, one-inch diameter, distilling column with magnetic head for the researches of Dr. O. L. Baril under an AIP grant. We are grateful to the alumni Benotti brothers, Joseph and Norbert, Directors of the Boston Medical Laboratories, for the gift of a flame photometer; and to alumnus W. P. Helfrich for the gift of a VTVM and CR Oscillograph, both from Heath Co. We are also grateful to the Shell Foundation of our 1959 and second *Shell Assist* of $500 (each) to

the Chairman of the Chemistry Department, to the Dean and to the President of the College. The acquisition of a surplus Plane Spotting Trainer, to be used as a film strip projector, has augmented our visual aids inventory.

The Department of Mathematics has received a grant of $60,200 from the National Science Foundation to be used in awarding stipends to sixty high school teachers who will attend the third consecutive Summer Institute for teachers of High School Mathematics to be conducted at the College from June 29 to August 7. During the present school year the department is sponsoring an In-Service Institute Program for high school teachers which is also under the auspices of the National Science Foundation.

On Saturday, November 29, 1958, the College was host to a meeting of the Northeastern Section of the Mathematical Association of America. One hundred and one members of the section attended. Dr. Vincent McBrien was elected secretary-treasurer of the section.

We hope to provide a picture of our new physical science building on the back cover of this issue. Our New England winter, almost record breaking for its severity this year, accounts for fewer delays than we expected, and we still have good hope of a timely opening in the Fall of 1959.

Loyola High School, Baltimore, Md. Fr. William J. Ruppenthal has been elected secretary of the Maryland Section of the American Chemical Society, the first priest and high school teacher to hold that office.

St. Joseph's College, Philadelphia. Dr. Bernard L. Miller, Professor of Physics at St. Joseph's has been awarded a Science Faculty Fellowship by the National Science Foundation, for study and research in connection with the improvement of College Science Teaching. These awards carry salary matching stipends as well as travel expenses. Dr. Miller will work at Stanford University in the field of Mathematical Physics.

St. Peter's College, Jersey City. In October 1958, Fr. G. J. Hilsdorf, Head of the Chemistry Department, issued an industrial index of St. Peter's College Alumni Chemists and his news sheet for alumni chemists.

University of Scranton. The chemistry department received a grant of $5,000 from the Smith, Kline and French Foundation. This will be used to increase research facilities.

A National Science Foundation grant has enabled the University to conduct a high-school science teachers institute during the school year.

Weston College. Recent *Weston Science Colloquia* include: Fr. James K. Connolly of Holy Cross, Jan. 11, 1959, on *Physical Indicators of the Age of the Universe*, for the 46th meeting; Dr. John J. McLaughlin, of St. Francis College in Brooklyn, N. Y., and Research Associate at the Haskins Laboratories in New York, Jan. 25, 1959, on *Dinoflagellates I Have Known*, lecture with motion picture film, for the 47th meeting; and Ralph Trese, Executive Director JRC, Feb. 26, 1959, on the *Jesuit Research Council*, for the 48th meeting of the Colloquium.

On Jan. 20, 1959 Fr. Daniel Linehan received the highest Navy award to a civilian—its Distinguished Public Service Award, for his outstanding contribution to the Navy in the field of scientific research and development. He had worked with Navy Task Force 43 and Operation Deepfreeze in the Antarctic during the International Geophysical Year. Thomas F. Gates, Secretary of the Navy, cited him for his "unselfish and untiring and patriotic services which you have so generously extended to the Navy."

The *Feature Parade Section* of the *Worcester Sunday Telegram* for March 8, 1959 carries on its cover a color portrait of Father *Dan* and contains a copiously illustrated feature article of his life and work.

Varia. Many of our colleges and universities are now adding Russian to their modern language curricula. A check with the Committee on Professional Training of the American Chemical Society as to language requirements for their approval revealed that "a reading knowledge of scientific German is required, and some use and application of it should be made during the study of one or more of the chemistry courses during the third or fourth year of the program. Russian or French is advised as a second language." . . . Mr. T. Spittler, S.J., graduate student in chemistry at Loyola University, Chicago, recently rescued a swimmer from the icy waters of Lake Michigan according to the *Chronicle* (PN of the Provinces of Chicago and Detroit). . . . The University of Detroit has made a grant in assistance of the research program of Fr. Wideman and Prof. McClellan on rapid freezing techniques in connection with the microscopic study of plant and animal tissues. Dr. R. J. Smith of the Department of Biology is conducting a research program involving the study of

certain plant parasites and the effect of hosts on them. He has received a grant-in-aid from the University for his work. . . . *The Bulletin of the Albertus Magnus Guild*, which appears monthly except July to September incl., gives rapid coverage of news items from Catholic Institutions including most Jesuit Colleges and Universities. For information about the Guild and its activities, write to Fr. P. H. Yancey, S.J., executive secretary and treasurer, Spring Hill College, Mobile, Ala. . . . Theologians of scientific bent at Innsbruck in Austria include Mr. R. Ratchford, S.J., a recent Ph.D. in chemistry from Catholic University, Messrs. D. J. Sullivan, Canavan, MacLean and Gersitz. . . . *Bulletin of the Albertus Magnus Guild* for Dec. 1958 carries a lengthy article on Fr. Roger Boscovich, S.J., on the occasion of the two hundredth anniversary of the publication of his *Theoria Philosophiae Naturalis, redacta ad unicam legem virium in natura existensium*, published in 1758.

SAFETY NOTICE

Three paste-in pages, dealing with safety precautions, were issued with vol. 38 of *Organic Syntheses*, Wiley, New York, **1958**. In the preparation of o-toluamide, (ibid., Coll. Vol. II, p. 586, 1943) heating in excess of 50° may produce large volumes (approximately 20 L.) of oxygen, accompanied by alcohol vapors which are thus easily ignited in presence of open flames. It is recommended: cooling to 40-50° C., good stirring and keeping at a safe distance from open flames. In the preparation of ethyl azodicarboxylate (ibid., **28**, 59, 1948) an explosion and speculation as to its cause were reported. It was recommended that ethyl azodicarboxylate be distilled only behind a safety shield, and protected from direct sources of light. In the preparation of methoxy-acetylene (ibid., note 10, **34**, 46 1954) minor explosions have occurred. Thorough shielding of apparatus is recommended in the preparations of both methoxy- an ethoxy- acetylene.

New Physical Science Building at the College of the Holy Cross in Worcester, Mass., showing north and west elevations. It will house the departments of Chemistry, Mathematics and Physics, the Science Library and many classrooms for general use. Completion is expected in September 1959.