A. M. D. G.

BULLETIN

of the

American Association of Jesuit Scientists

Eastern States Division

(Founded 1922)

(for private circulation)

Published at
COLLEGE OF THE HOLY CROSS
Worcester 3, Massachusetts

VOL. XXVI DECEMBER, 1948 NO. 2

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Bulletin of the American Association of Jesuit Scientists

EASTERN STATES DIVISION

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Science and Philosophy

THE UNCERTAINTY PRINCIPLE—AN EPISTEMOLOGICAL INTERPRETATION

REV. JOSEPH P. KELLY, S.J.

The Heisenberg Uncertainty Principle is a scientific principle and, of itself, is limited to the realm of scientific knowledge. We can state it thus: "It is impossible to obtain accurate values for the position and velocity of an electron simultaneously." The values mentioned are "measured" values. The principle marks, one might say, the limits of the quantitative Principle of Causality, with respect to measurement in the sub-atomic field. For, according to the Principle of Causality, if we know, in a quantitative, measurable sense, an antecedent phenomenon, we can infer the knowledge of a consequent phenomenon which follows in accord with some physical law. The classical physicist believed that it was possible, at least in principle, to predict with mathematical accuracy the consequent event. In scientific practise today, the principle still holds for macrocosmic or large-body measurements where the margin of error is either too small to be detected or is negligible.

When the scientists applied the principle of Causality to motions of subatomic particles like the electron they discovered that measurement of this type was not available because the very process of measurement disturbed the actual conditions under which the measures were sought. Planck sums up the status thus: "Now it was found that every method permitting of exact measurement of the electron's position prohibits an exact measurement of its velocity; and it was further found that the inaccuracy of the latter measurement varies inversely with the accuracy of former and vice versa, the phenomenon being governed by a law which is accurately defined by the magnitude of Planck's quantum. If the position of the electron is known exactly, its velocity is not known at all and vice versa."[1] Thus we have the Uncertainty Principle.

Some scientists claim that there is an analogous situation in the interpretation of light phenomena, in the wave and corpuscular theory. In cases of propagation in a straight line, reflection in mirrors, the better interpretation follows the corpuscle theory; on the

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AUTHOR'S NOTE. This article was suggested from DeBroglie, "Matter and Light", especially Section V, entitled: "Philosophical Studies on Quantum Physics", p. 217 sq.

Cf. DeBroglie, "Matter and Light". Translated by W. H. Johnston. Dover, N. Y., 1946.

[1]Planck, "The Philosophy of Physics," p. 18. Norton, N. Y., 1936.

other hand, interference phenomena find a more satisfactory explanation in the wave theory. If the wave aspect is stressed, the corpuscular aspect recedes and vice versa. In the case of two or more electrified particles, reacting on one another we may predicate the potential energy of either the system or of the individual particles. If we attribute the energy to the system "the particles suffer mutilation" so to speak; if we say that the energy belongs to the particles, the system fades into the background. Yet for an adequate explanation of all these phenomena both aspects are required, viz: wave and corpuscle, position and velocity, individuals and system. No one would of itself be sufficient. Each represents a certain phase of the event but not all. Concepts of this sort are known in science as "complementarities", and have their origin in the Uncertainty Principle. In themselves they are somewhat "indeterminate" (contain a certain margin of error); they are complementary since each demands the other in a rational interpretation of events. They cannot be reduced one to the other and in a sense they are mutually exclusive because as one approaches reality the other recedes from it.

It is in this, says DeBroglie, that we find the true philosophical interpretation of the Heisenberg Principle, namely, that it reveals to us concepts which have an indeterminateness in themselves and at the same time a "relation of complementarity". For, our approach to the real must be through the cognoscitive faculties and the knowledge resulting therefrom. So, there must be a correspondence of what we know with reality; knowledge is the mirror of reality. Hence, considering our knowledge in its measurement-aspect, the more accurate our measure of the object, the clearer our knowledge and the nearer our approach to the real. Conversely, the less accurate the measure, the farther away from reality. This general correspondence follows the Scholastic definition of logical truth: the conformity of the intellect with the object. This type of concept is not exactly new in physical science but the Uncertainty Principle has placed more emphasis on it than hitherto in the interpretation of physical phenomena.

It has been suggested that these "complementary" concepts may find an application in analogous situations outside the realm of the natural sciences and may aid in the clarification of some ideas. For, we must recognize that some of our notions contain something of indeterminateness with respect to reality. When one speaks in praise of the work of a college faculty, the individual professors are represented only vaguely in the totality of the faculty group; if one singles out the professors, the faculty concept tends to recede—so also, in the relation of individuals to any society. And in the case of some definitions, if taken in a broad sense, they may be applied well enough to a large group but if taken in a rigorous sense, may find a much more limited verification. A large number of men may be called "honest" in a general sense of the term; but if one maintains a stricter definition, viz: one who have *never* violated a precept of honesty, "we have here only an idealization, the probability of whose full realization tends to vanish."

Taken at face value there is much to be said in favor of this philosophical interpretation of the Heisenberg Principle. These comparisons, however, cannot be pressed too far and the analogies are valid only within limits or with the proper distinctions, as we say. There is evidently a difference between a society composed of human beings and an organization of inanimate, physical objects or chemical elements. This difference arises both from the very nature of the beings themselves and from their mode of union. The human being always remains an individual and maintains his personality in a society and is never completely absorbed, as it were, in a system. This is one of our strongest objections to all totalitarian societies, that they deny the individuality of the persons composing the society. Again, in the relationship between the subjective and the objective in the order of thought, we see that the object is a very complex thing compared with the relative simplicity of thought. We grasp only one thing or aspect at a time. This compels us to adopt some method of approach to the real in order to understand it. Hence, the human mind by its innate power, tends to an abstract form of thought, concentrating on one phase of the real, abstracting it from the whole. This creates a certain "indeterminateness" with respect to the concrete totality. We cannot comprehend the complexity of the human being in a single thought nor exhaust the study of man in a single science. Witness the variety of courses in psychology or sociology in any college catalogue. The same holds for the complexity of inorganic elements that make up the physical world. This is abundantly evident from the numerous divisions and subdivisions of the physical sciences. Laws of nature are expressed in mathematical formulae or in propositions which are really abstractions or idealization. These cannot be verified exactly according to the abstract form; allowances must be made for the concrete conditions under which the laws operate. This failure to distinguish between the abstract and the concrete or perhaps better, the attempt to substitute the abstract for the concrete has been the cause of many errors even in the physical sciences. To transfer concepts, derived from one particular system, to another without due consideration for the conditions of both systems is fraught with grave dangers to truth. Thus, DeBroglie stresses the point that in science we have many abstract principles or idealizations which, as such, cannot be applied to the objective, physical world. The practise of the scientists confirms this, since in all cases they make allowance for margins of error or apply correctives for actual conditions under which the application is made. However, in theory and sometimes in the philosophical interpretation of scientific notions, this principle seems to be forgotten. An abstract definition or principle may be clear in itself; it may be well understood in the order of concepts but its relation to the actual physical world may not be so easily comprehended. Speaking of this relationship in the correspondence between the real "which is infinitely complex and full of an infinity of shades" and on the other hand, our understanding, forming concepts which are "more or less rigid and abstract", this he calls the "margin of indeterminateness". It is worthy of some consideration on the part of the philosophers to clarify our thought in relation to the objective order. We think that this problem brings us back to the question of the "Universals" with the famous distinction: "juxta id quod" and "juxta modum quo" or once more to the perennial problem of the one and the many.

In view of these and other questions that have arisen in scientific fields it is not surprising that some of the scientists are weighing the possibility of a philosophical interpretation of some of these problems. Has the intrinsic consideration of physical theory logically forced the scientist into philosophy? It might seem so, noting that the suggestions have come more from scientific than from philosophical discussion. Certainly, even among scientists there is a frank avowal of the need of some sort of philosophical background and a reconsideration of basic notions. Heisenberg recognizes that his principle states a radical modification of the position of the physicist, in opposing Indeterminism to Determinism. Or perhaps as Eddington remarks, the question is whether the future of physics is to be based on Determinism or Indeterminism.[2] At any rate, it seems to lead to a reconsideration of the foundations of science. Heisenberg says: "It is now profitable to review the fundamental discussion, so important for epistemology, of the difficulty of separating the subjective and the objective aspects of the world. Many of the abstractions that are characteristics of modern theoretical physics are to be found discussed in the philosophies of the past centuries. At that time these abstractions could be regarded as mere mental exercises by the scientist whose only concern was reality. But today we are compelled by the refinements of experimental art to consider them seriously."[3]

BULLETIN DE LIAISON ENTRE SCIENTIFIQUES, S. J.

William G. Guindon, S.J.

There exists today in France a small group of Jesuits devoted entirely to the scientific apostolate, who are very anxious to broaden their contacts with Jesuit scientists the world over, and who for this end have made informal inquiries as to the possibilities of cooperative labor with us.

(Continued on page 66)

[2]Eddington, "New Pathways in Science", ch. IV. Macmillan, N. Y., 1935.

[3]Heisenberg, "The Physical Principles of the Quantum Theory", p. 65. Chicago, 1930.

Biology

THE Rh FACTOR—ITS DISCOVERY AND RECENT HISTORY

William K. Masterson, S.J.

The discovery of the Rh factor in human blood ranks today as one of the most important medical events of an era already surfeited with amazing advances. The story of the Rh factor really begins back at the turn of the century, in the year 1900, when Dr. Karl Landsteiner, who has since become the world's foremost authority on the immunological aspects of the blood, discovered that the sera of some humans agglutinated (clumped) the cells of other humans, thereby demonstrating that there were differences in the blood of members of the same species. This clumping phenomenon is called isohemagglutination.

This discovery marked the dawn of the science of Hematology. All humans were divided into one of four groups, *A*, *B*, *AB*, or *O*. Then, in 1928, Dr. Landsteiner, this time with his brilliant young pupil, Dr. Philip Levine, described another system of blood groups which were named *M*, *MN*, and *N*. This group has proved valuable in determining paternity or non-paternity in medico-legal cases.

However, by the late thirties, medical investigators were still very much puzzled by the occurrences of many cases of transfusion reactions that were unexplainable on the basis of *A* or *B* incompatibility. Then, in 1937, Drs. Landsteiner and Wiener injected their experimental rabbits with the blood of a rhesus monkey. After having removed from the sera of these injected rabbits the antibodies produced against *A*, *B*, *M* and *N*, they found that the serum from the rabbits still clumped the cells of thirty-nine out of forty-five human bloods selected at random. It was believed that this serum contained specific agglutinins unlike any other then known. With this discovery a new blood group was born.

The new character in human blood cells which was brought to light by this new agglutinin from the rabbit sera, was called "Rh" because the rhesus monkey was instrumental in its production. Cells containing the Rh antigen, which were clumped by this serum, were called Rh-positive (Rh+); those cells lacking the Rh antigen, and which were not clumped by the serum, were called Rh-negative (RH—).[1] The Rh factor was discovered. Now it had to be proved that this factor actually exists in human blood, and that it acts like a true antigen.

[1]Potter, Edith L., "Rh . . . its Relation to Congenital Hemolytic Disease & to Intragroup Transfusion Reactions," Chicago: The Yearbook Publishers, 1947, p. 33.

On August 13, 1939, a fifty-two year old patient was admitted to the surgical service of Mercy Hospital in New York. In the course of thirteen days following an operation, five transfusions were administered. Fifteen minutes after the last transfusion, the patient developed a severe hemolytic reaction and died a few days later. In investigating the case, it was found that the reactions that took place coincided statistically with the action of the anti-rhesus immune serum prepared by Landsteiner and Wiener. This remarkable parallelism was noted in two other cases of severe transfusion reactions, and gave rise to the concept of Rh-isoimmunization.[2]

Wiener and his co-workers, realizing the new horizons this new discovery opened up, enthusiastically set to work to apply it as a solution to various cases of puzzling transfusion reactions. Many cases were studied. It was noted that almost all the individuals suffering from Hemolysis (i.e. destruction of the red cells) had been either previously transfused, or recently pregnant.

How did persons become immunized to the Rh factor? Wiener reached the conclusion that Rh-immunization was *acquired*, not inherited. According to him, natural immunity to the Rh factor does not occur. An Rh-negative person must first be exposed to Rh-positive blood either by transfusion, or by pregnancy. Wiener further concluded that the Rh factor was a new blood group, that it was equally distributed in both sexes, and that it was inherited as a mendelian dominant.

While Wiener and his associates were working with rabbit antibodies and were trying to determine the specificity of the anti-Rh agglutinins, Dr. Philip Levine and his group at the Beth Israel Hospital were focusing their attention on the causes of hemolytic reactions in obstetrical cases. They were puzzled by cases of severe and sometimes fatal intra-group transfusion reactions associated with pregnancies.

According to Levine's theory, the Rh factor played the villain's role in obstetrical cases in the following way. When an Rh-negative woman marries an Rh-positive man, and conceives an Rh-positive child, the blood cells of the fetus may pass through the placenta and enter the maternal circulation. These cells act as foreign substances in the mother's blood stream and stimulate in her blood antibody production. The antibodies called forth then pass from the maternal blood into the fetal blood circulating in the placenta. When these anti-Rh agglutinins come into contact with Rh-positive agglutinogens in the fetus, an antigen-antibody reaction takes place. Gradually, with more or less severity, depending on the titre (strength) of the antibody produced, the fetal blood is destroyed.

In spite of the clarification of many of the basic mechanisms in hemolytic disease within the past five years, the mortality rate for hemolytic infants remains still quite high. For example, in a recent

[2]Wiener, A. S., and Peters, H. R., Ann. Int. Med., *13*, 2306 (1940).

report on observations made on ninety-six Rh-immunized women, it was stated that almost two-thirds of the hemolytic infants delivered in this series, died.[3] As the situation stands today, there is no specific measure that will prevent fetal blood cells from migrating across the placenta, there is no way to prevent the formation of antibodies on the part of the mother.

Regarding this Rh-isoimmunization phenomenon, it is important to understand that the process is a gradual one. The reason for the slow effect is not definitely known, but it seems to be due to the gradual build-up of antibody concentration. In general, it is true to say that the first-born child of an Rh-negative mother rarely will have hemolytic disease unless the mother has been previously immunized by an incompatible transfusion, or by an abortion. However, once an Rh-negative mother has given birth to one infant with hemolytic disease, every Rh-positive child born subsequently will be affected in the same way.

Something ought to be said, at this point, about the statistical incidence of hemolytic disease in the general population. Only statistics of a general nature can be given because the entire Rh problem is still under active investigation. Dr. Philip Levine seems to be the most reliable source on the occurrence of hemolytic disease since he was the pioneer investigator of the phenomenon of Rh-isoimmunization in pregnancies. He summarizes the situation as follows:

> It has been observed on clinical evidence alone that erythroblastosis fetalis occurs about once in every 438 deliveries. If Rh tests are done in all cases of fetal and neonatal morbidity, one can assume an incidence of about 1:150 to 1:200 deliveries. Even this value is out of proportion to the number of pregnancies in the 13 per cent of susceptible matings, i.e., Rh + father × Rh — mother. Accordingly, it is necessary to assume several factors of safety: (1) the current tendency to small families; (2) inability of many Rh—women to produce antibodies; and (3) the high incidence of heterozygous fathers.[4]

In the search for the answer to Rh-isoimmunization and the prevention of *Hemolytic Disease of the Newborn*, three possible solutions have been considered by investigators. They are:

1. To allow nature herself to remedy Hemolytic Disease by eliminating in time the recessive *rh* gene.
2. To employ artificial means, such as, exchange transfusion, radical obstetrics, abortion, contraception, sterilization, and artificial insemination.
3. To fight nature with her own weapons by neutralizing the antibody produced.

There are no solid grounds for asserting that the recessive *rh* gene will be eliminated, hence, let us pass on to the second remedy,

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[3]Sack, M. M., and Kuhns, W., Amer. Journ. Obst. and Gynec., *54,* 3400, (Sept. 1947).

[4]Levine, P., "The Rh factor in the Clinic and the Laboratory," Joseph M. Hill and William Dameshek, editors. New York: Grune & Stratton, 1948, pp. 17-18.

namely, artificial prevention. This is by far the main line of approach to the problem at the present time. The above enumeration of the artificial means being used gives some indication of the moral aspects of the Rh problem.

Of all the artificial preventative means employed to counteract Hemolysis, the exchange transfusion has been the most successful. As soon as a new-born baby is diagnosed as hemolytic, it is made ready for exsanguination. Only type-O Rh-negative blood that is antibody-free, is used. The object of the exchange transfusion is to remove the antibody and to replace positive cells with negative cells. The transfused Rh-negative cells cannot be destroyed by the antibody which was previously manufactured by the mother, and which now circulates in the fetal blood stream. But, a transfusion of Rh-positive blood would immediately furnish more cells to be destroyed by the circulating antibody. Nevertheless, the exchange tranfusion is not the complete answer to hemolysis due to Rh-isoimmunization. Neither exchange transfusion nor radical obstetrics have been able to save premature infants and those afflicted with the terrible fetal hydrops.

In view of all this, it has become increasingly evident to investigators that the answer to the Rh factor lies elsewhere. In a recent paper, Dr. William C. Moloney of Boston, a recognized authority on the Rh problem, said in part:

> The ideal approach to the problem of Rh-isoimmunization in pregnancy would be to block, absorb, or inhibit the production of antibodies. Various methods have been proposed to "compete" with, or counteract the immune response to the Rh factor, but these are in the experimental stage and are not at present available for clinical use.[5]

This is the third remedy, a remedy which is now under active investigation.

Some favorable results have been reported in neutralizing the antibodies with certain types of allergy drugs, and with the so-called "Rh-negative protective factor" which is said to occur naturally in the blood of some Rh-negative individuals. However, until these reported remedies have been successfully used by many physicians, they will remain unconfirmed. But, the research work goes on apace, and soon, perhaps very soon, the true remedy for the Rh factor will be found.

CANISIUS COLLEGE HERBARIUM

REV. JOHN A. FRISCH, S.J. AND JOHN L. BLUM

Canisius College now has a working and useful herbarium, a collection of preserved plants from all parts of the world. Prior to 1942 the collection remained for no one knows how many years in

[5]Moloney, W. C., "The management of the Rh problem in pregnancy and in the newborn," unpublished material, Boston, 1947, p. 7.

the attic of the main building at Canisius, untouched by man and (most fortunately) by insects and molds. In 1942 the work of mounting the specimens on herbarium paper, poisoning them to defeat the efforts of future generations of moths, and classifying them, was undertaken, and has by now been completed, mostly through the efforts of Joseph Stanford, John Conboy, Fred Champlain, John Blum, and other members of and students in the Biology Department.

The collection as it is today consists of about 2800 specimens, each carefully mounted and named and filed away in a special order much as books are filed in a library. The most recent collecting here represented has been done by John Blum and Clifford Awald. A large collection of local plants made in the thirties by F. James Dorst, Buffalo botanist, was recently contributed to the college and forms a large part of the collection.

But the most interesting collections are the older ones. Some years ago St. Joseph's Collegiate Institute of Buffalo gave to the college a large collection of plants made about 1908 in Southern France and Spain largely by three brothers, Fr. J. Peter, Fr. H. Elias, and Fr. Casimir Joseph. This is the most attractive of the collections in the Canisius Herbarium, for these brothers were interested especially in the wild flowers of the Pyrenees, which they collected and mounted with meticulous care.

Another European collection of many hundreds of plants made between 1880 and 1900 by one or more unknown Jesuits, is included. Part of these collections were made in Switzerland and part in and around the Jesuit house at Valkenburg, Netherlands.

The largest of the individual collections is that of Rev. J. H. Wibbe, Ph.D., a priest of Oswego, N. Y., who in his lifetime founded a botanical garden at Oswego which was widely known for the variety of native and foreign plants it contained. Canisius was so fortunate as to obtain a large part of Dr. Wibbe's collection of dried plants after his death. Unfortunately Fr. Wibbe did not keep sufficient data with the specimens he collected, and many collection localities are indicated by him simply as "Nebraska", "Mexico", "Europe" or even "North America", in contrast to the practice of botanists today, who designate the locality of each of their collections down to the direction and distance from the nearest village.

But the most time-honored and valuable part of the entire collection is a group of 400-500 plants gathered about 1840 in the vicinity of New York City. For over a hundred years this collection has remained in disuse. The original labels, in large part correct and with complete data, except for the name of the collector, remain with the specimens, now well mounted and preserved. The botanist who collected them, obviously a well-trained man, is quite unknown to us. Some day we hope to find out more about him, since, although he did not realize it, he is the real founder of the herbarium of Canisius College.

Chemistry

UNDERGRADUATE ORGANIC SYNTHESIS

Rev. Bernard A. Fiekers, S.J.

I. *Oxidation by Nitric Acid. Adipic Acid, Its Homologues and Derivatives*

In this paper we offer a procedure in organic synthesis for undergraduates that was adapted to the purpose from the literature by way of undergraduate laboratory theses; tested by graduate students in the course of their synthetic work; and tried by one class of undergraduates, with results that warrant our passing it on to other departments for their consideration and use. The form, that this procedure takes, is aimed at providing colleges with a series of, what we might call, "manifold experiments", that feature an "instructor's choice" of starting materials and products from the many homologues and derivatives of common commercial substances. It is hoped to align many applications of a reaction under a common procedure. We realize that this can hardly be done without compromising the details of a procedure to the applications we choose; but we feel that such a compromise need not be overdone, and that many advantages from the use of such an instructional technique will outweigh the disadvantages. The procedure follows.

OXIDATION WITH NITRIC ACID. RING CLEAVAGE

Notice. Directions given in this experiment for agitation and temperature control should be observed implicitly and explicitly! This reaction is exothermic. Cyclohexanol should *not* be allowed to accumulate unreacted in the mixture.

Procedure. Assemble a 500 ml., 3-neck, round-bottom flask, fitted with reflux condensor, thermometer and a small dropping funnel. Construct a trap for catching nitric oxide fumes as follows (Adams, R. and Johnson, J. R., Elem. Lab. Expts. in Org. Chem., 3rd ed., MacM., N. Y., 1942, p. 139, fig. 18): A U-tube is made of 8 mm. glass tubing; fitted tightly through a cork to the top of the reflux; and connected from its other extremity to the tip of an inverted funnel by means of a suitable length of rubber tubing. The funnel hangs inside a beaker on the desk top so that its rim is about halfway down the beaker. The beaker is then filled with water to about ¼ inch above the rim of the funnel. 5-10 gm. solid ferrous sulfate are then dissolved in the water. This solution is replaced from time to time during the reaction if nitric oxide fumes persist in escaping into the laboratory. An ice and water mixture is made up in a shallow dish for cooling the reaction flask at the bottom when raised to it by hand. If the ice pieces are small and sufficient water is present, good cooling contact is assured.

50 ml. conc. HNO_3 are diluted to 80 ml. (105 gm., 50% HNO_3) and intro-

duced into the flask. Ammonium vanadate crystals—no greater volume than the head of a safety match—are added to this. The bulb of the thermometer is then immersed into the surface of the acid mixture. 25 ml. of either

Cyclohexanol, (for adipic acid product) or

4-Methyl Cyclohexanol, (for 3-Methyl adipic acid)

(Instructor's Choice)

are poured into the dropping funnel.

The acid is first heated to boiling. At first only 5-10 drops of cyclohexanol are admitted. Brown nitric fumes indicate the start of the reaction. The reaction is then cooled with the ice bath until the temperature of the mixture lies between 55 and 60°. The cyclohexanol is then added, with a minimum of delays, WHILE THE TEMPERATURE IS KEPT *BETWEEN* THESE LIMITS and the mixture is agitated by hand with a gentle rocking motion of the apparatus assembly. Mechanical stirring, if available, is preferred.

Towards the end of the reaction, heat may have to be applied in order to complete it. With no more of the cyclohexanol to add, the mixture is *cautiously* brought to reflux temperature and held there for fifteen minutes in order to drive oft the nitric fumes.

The mixture is then cooled in an ice bath for 30 min., preferably at room temperature overnight. The precipitated acid is then filtered on a Buechner funnel, washed with *cold* water and dried overnight.

The sample is to be bottled dry. Report the yield with sample. YIELD 20 gm.

QUESTIONS. From structural considerations, compare this oxidation with that of ethylene glycol. —with that of an acyclic secondary alcohol. Why is the catalyst used? What products would you expect to get from 2-Methyl cyclohexanol? —from 3-Methyl cyclohexanol? Why does the technique of purification differ from that of the oxidation of ethylene glycol to oxalic acid? Give equations for the reaction performed. Would the procedure have to be varied in the oxidation of 4-tert Amyl cyclohexanol?

This experiment seems to the author to have certain administrative and instructional advantages. The work on it was started in an effort to study fume control in organic laboratory and to bypass the problem of stirring.

There is a common impression abroad that an organic laboratory should be provided with fume hoods all the way from an adequate supply to the definite requirement of a hood at each work space. Due to the crowded conditions of college laboratories today, many standard experiments have to be passed over on account of the lack of ventilation facilities. And still in normal times, one can never seem to supply sufficient facilities for the purpose. Certainly undergraduates should conduct certain experiments under the hood sometime in the course of their work. It seems to the author that the minimum adequate supply of fume hoods, should include provision for the ordinary dispensation of corrosive reagents along with sufficient hood space for occasional work with it. To overdo the hood proposition is to crowd the laboratory unnecessarily; sometimes to create an illumination problem throughout the laboratory; certainly to create the administrative problem of having to keep hoods clear for action since they are almost always, everywhere, a convenient storage spot for odds and ends of apparatus and have to be patrolled incessantly. It seems that fume control of the type indicated in this experiment and carefully worked out for other experiments should alleviate any problem of hoods.

It will be noticed that the mixture has to be agitated by rocking the assembly by hand. Where stirrers are available in quantity, this mode of agitation becomes unnecessary.

An additional administrative advantage in this particular experiment is the fact that it can be performed at the beginning of second term in organic chemistry. It is generally very difficult to find suitable experiments to be performed at this time in the course. For, much of the theoretical material taken up at this point is arbitrarily chosen and varies from text to text. The instructional features of this experiment, brought out to some degree by the questions appended to it, support this reason of order and timing.

Reviewing the questions appended to the experiment, we find that ring cleavage is had in this experiment, a feature that is not to be found in the oxidation of ethylene glycol. That is why the catalyst is used. The symmetry of 4-Methyl Cyclohexanol, as opposed to the lack of it in the 2-Methyl and 3-Methyl varieties, allows for cleavage on either side of the —OH group to produce the same product. Cleavage of the 2- and 3-Methyl varieties is expected to, and actually does,[a] produce a mixture of dibasic acids. The solubility of the adipic acids is low enough to allow for their separation from the mixture by crystallization on cooling. In the case of oxalic acid, the solubility is greater and the volume has to be reduced in order to effect a separation. The oxidation of a secondary acyclic alcohol or acyclic ketone to the acid stage involves the production of a mixture of acids, depending on which side of the functional group the rupture of the carbon-carbon bond might have occurred. With symmetrical cyclic compounds, dibasic acids are produced in almost quantitative yield and mixtures are avoided. The experiment provides an occasion for bringing out reasoning such as this.

It is, however, the idea of a "manifold" experiment with instructor's choice that we would like to emphasize in elaborating an example of one. The fact that choice of material is worked out in it, is of definite administrative advantage, if we but reflect for a moment on the shortages and delayed deliveries of the last war. With such an experiment one now has a greater chance of using stocks that may be on hand. It seems too that practically the same procedure could be applied to the oxidation of cyclic ketones. Probably the absolute quantity of nitric acid would have to be reduced.

In normal times, one student could do one of the homologues; another, another, and so forth. Psychological advantage could be

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[a]Course work of Messrs. E. J. Kilmartin, S.J. and C. F. Turner, S.J.

taken of the interest that one student has in the work of his laboratory benchmate. Indeed, such an experiment does not teach the isolated fact of the production of adipic acid alone; it embraces a family of compounds with good reflection on the principles of symmetry involved, with comparisons to be made with other classes of of compounds, and with consideration of variations in physical properties that homology and cross classification demand. Circumstances can be imagined where chemical economy and the source of one organic compound from others could be applied.

FILM REVIEW

Phosphorus, Key to Life, 16 mm., sound, color, 35 min., American Agricultural Chemical Co., 50 Church St., New York 7, N. Y., lent gratis.

There are many excellent films in circulation today and *Phosphorus, Key to Life* is one of them. So many too are not worth the time spent in attending them—it seems that the good ones should be reviewed in print. For, one can borrow a book and review it for himself, if needs be; one cannot peruse a film with ease or gain as ready access to it.

In this film Lowell Thomas is the narrator, and the narration is conducted against a subdued orchestral background. It should be of interest to the farmer, to whom it is probably directed, the dietician, medical man, biologist and chemist. Shots on analytic and control work in the laboratory, or industrial chemistry in the mining and processing of phosphorus, on the handling of white phosphorus under water, on the production of the pentoxide and its acid solution are all presented in a colorful way to catch the enthusiasm of the chemist. The microscopic scene of the division of living cells in growth and the agricultural control scenes should provide highlights for the student of biological sciences. The engineer will be intrigued by the huge draglines used for the mining of phosphate rock in Florida. They are probably the largest land machines in the world. The dietician, practicing physician and, above all, the farmer should find the showing most valuable. Advertising is not offensive.

If constructive criticism is called for the following points might be made with possible profit. The lighting of matches against a box on an ashtray, with the heads of the matches exposed, is bad safety practice. Further, a chemist might expect some mention of red phosphorus. Others might take away the impression that all phosphorus must be kept under water. It seems that the narrator loops back too frequently on topics that have passed; he seems too to indulge in perorations that hesitate to close. This review can be closed, however, with a high recommendation for the film.

B. A. F.

Mathematics

BERNARD BOLZANO, 1781-1848

REV. ARTHUR STEELE, S.J.

Bolzano did more than share a theorem with Weierstrass. He was the Catholic Priest who helped to put back logic into mathematics, and to take the psychology out of logic.

Eudoxus and Archimedes, Weierstrass and Hilbert mark peak centuries in logical precision and problematic tone. The century of the "enlightenment" and the "encyclopaedia" was a hollow. Success in applications, ill-formulated controversies, superstitious trust in symbols—all masked questions of existence and uniqueness and validity. At length, Protestants like Abel and Gauss, Catholics like Cauchy and Weierstrass, together with Father Bolzano, burnt the eighteenth-century rubbish and inaugurated modern rigour. Without them, the latest problems of mathematical philosophy could never have been mooted at all.

Only a fraction of our fresh material on Bolzano can be so much as adumbrated here. Fuller accounts and fuller *documentation* are given in the Historical Introduction to a forthcoming translation of the *Paradoxien*. Though widest known, this work does not contain its author's best mathematics, which must be sought in six earlier tracts with the short titles: *Betrachtungen*, 1804; *Beyträge*, 1810; *Drei Dimensionen*, 1810 and 1843; *Binomischer Lehrsatz*, 1816; *Rein analytischer Beweis*, 1817; and *Drei Probleme*, 1817.

For Bolzano in his prime, mathematics is a science of relation, not quantity. Theorems need analyzing out as far as ever possible into primitive and derived. Axiomatics and isomorphisms must unify mathematics and seal its analogies. Definitions and proofs must be always connatural, never adventitious. Above all, mathematical *variability* connotes, in Bolzano for the first time, no longer *change* but rather *anyness* within a specified domain.

Bolzano distinguished upper bounds from maximum members, defined continuous functions without appeal to jumplessness, and coined the phrase "attain and retain" for improving the verbal definition of a limit. He constructed an ordinate set, and once condensed singularities prior to Hankel. Simple though his cases were, he did set up measure functions expressly through isomorphism between number-addition and magnitude-juxtaposition. Briefly, and in many little ways, Bolzano well deserves the title conferred by Klein: that of "Father of Arithmetisation".

The possibility that whole and part stand in biunivocal correspondence was noted earlier, by Proclus and Galileo; the *Paradoxien* go farther, yet not far enough. They erect this "holomerism" into a criterion for infinite sets, but fail to erect biunivocal correspondence as such into a criterion for equinumerosity. Indeed, some later paragraphs badly fumble clear cases of the latter, and say, for example, that an area have more points than its periphery.

Less well known is Bolzano's greater achievement of constructing, thirty years *prior to Weierstrass*, a function *everywhere continuous but nowhere differentiable*. As in more recent examples, his principle is the perpetual transition from a straight join to a uniformly related zigzag join; more specifically, if the end points are (x, y) and $(x+8p, y+8q)$ with p and q non-zero, Bolzano puts three elbows, at $(x+3p, y+5q)$ and $(x+4p, y+4q)$ and $(x+7p, y+9q)$. Subsequent studies have disclosed several other idiosyncrasies in Bolzano's function.

The *Wissenschaftslehre* of 1837, in four volumes and 2397 pages, is a masterpiece but recently appreciated by historians of logic; best by H. Scholz in 1929. It is full of original investigations, fine distinctions, semantic scruples, and documentation for the history of logic. Mathematicians will be attracted by Bolzano's discovery of the *logical variable* and the *propositional function*, by his use of them in developing a strictly formal logic, by his study of several special logical functions, and by his notion of probability as a relation between propositions rather than a ratio of case-enumerals.

Bolzano censured Kant for calling logic a closed chapter, and made the brilliant prophesy that "many a fresh discovery remains to be made in logic."

A TEST FOR THE CONVERGENCE OF AN INFINITE SERIES OF POSITIVE TERMS

Part I

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Judging from my own limited experience, once a problem dealing with the convergence of an infinite series of *positive* terms

$$[\text{i.e., } \sum_{n=1}^{\infty} \mu_n, \text{ with } \mu_k > 0 \text{ for all k}]$$

is proposed, the ratio test is instinctively applied because of its simplicity.

In a large number of cases—we might even be tempted to say the majority of cases—such a test fails because the ratio:

$$\lim_{n\to\infty} \frac{\mu_{n+1}}{\mu_n} = 1.$$

If a simple series suitable for the application of the Comparison

Test is not immediately discernible, one must rack one's memory for the Maclaurin-Cauchy Integral Test, Kummer's Test, or Gauss' Test—most of which are not available to the student of elementary Calculus, and all of which demand that the series fulfill certain conditions before they may be applied.

There is a simple alternative test which will solve such problems, and it is as easily applied as the Ratio Test itself. It is derived from Gauss' Test (derivation in the following article), and may be stated as follows:

If in a series of positive terms, $\lim_{n \to \infty} \frac{\mu_{n+1}}{\mu_n} = 1$, and if $\frac{\mu_{n+1}}{\mu_n}$ is reducible to the form $\frac{n^k + a_1 n^{k-1} + a_2 n^{k-2} + \cdots}{n^k + b_1 n^{k-1} + b_2 n^{k-2} + \cdots}$ the series is convergent when $b_1 - a_1 > 1$ and divergent when $b_1 - a_1 \leqq 1$.

For example:

1. Consider the series:

$$\frac{1}{2} + \frac{1.3}{2.4} + \frac{1.3.5}{2.4.6} + \cdots + \frac{1.3.5.\cdots(2n-1)}{2.4.6.\cdots(2n)} + \cdots$$

$$\lim_{n \to \infty} \frac{\mu_{n+1}}{\mu_n} = \lim_{n \to \infty} \frac{2n+1}{2n+2} = 1;$$

therefore the Ratio Test fails.

Now apply the test under consideration:

$$\frac{\mu_{n+1}}{\mu_n} = \frac{2n+1}{2n+2} = \frac{n+\frac{1}{2}}{n+1}, \text{ where } a_1 = \tfrac{1}{2}, \text{ and } b_1 = 1$$

Since $b_1 - a_1 = 1 - \frac{1}{2} = \frac{1}{2} < 1$, the series is divergent.

1. Consider the series:

$$\frac{2}{1+1^4} + \frac{4}{1+2^4} + \frac{6}{1+3^4} + \cdots + \frac{2n}{1+n^4} + \cdots$$

$$\lim_{n \to \infty} \frac{\mu_{n+1}}{\mu_n} = \lim_{n \to \infty} \frac{(2n+2)}{1+(n+1)^4} \cdot \frac{1+n^4}{2n} =$$

$$\lim_{n \to \infty} \frac{2n^5 + 2n^4 + \cdots}{2n^5 + 8n^4 + \cdots} = 1;$$

therefore the Ratio test fails.

Now apply the test under consideration:

$$\frac{\mu_{n+1}}{\mu_n} = \frac{2n^5 + 2n^4 + \cdots}{2n^5 + 8n^4 + \cdots} = \frac{n^5 + n^4 + \cdots}{n^5 + 4n^4 + \cdots}$$

where $a_1 = 1$, and $b_1 = 4$.

Since $b_1 - a_1 = 4 - 1 = 3 > 1$, the series is convergent.

Strangely, neither the frequent need for such a test, nor its obvious simplicity seem to warrant it a place in the ordinary Calculus texts. We bring it to the attention of the readers of the BULLETIN in the hope that those who may not have known of its existence may find it of value in their teaching.

PART II

Proof of Preceding Test

WALTER J. FEENEY, S.J.

Lemma: Gauss' Test:

If the series $\sum_{n=1}^{\infty} \mu_n$ of positive terms is such that the ratio $\frac{\mu_n}{\mu_{n+1}}$ can be written in the form

$$\frac{\mu_n}{\mu_{n+1}} = 1 + \frac{h}{n} + \frac{A(n)}{n^2}$$

where $A(n)$ is a bounded function of n as $n \to \infty$, then the series converges if $h > 1$, and diverges if $h \leqslant 1$. (For proof cf. Sokolnikoff: *Advanced Calculus*, p. 230.)

Hypotheses:

1°. $\sum_{n=1}^{\infty} \mu_n$ with $\mu_k > 0$ for $k = 1, 2, - - - - -$

2°. $\lim_{n \to \infty} \frac{\mu_{n+1}}{\mu_n} = \lim_{n \to \infty} \frac{n^k + a_1 n^{k-1} + a_2 n^{k-2} + - - - -}{n^k + b_1 n^{k-1} + b_2 n^{k-2} + - - - -}$

3°. $b_1 - a_1 > 1 \quad [\leqslant 1]$

Conclusion:

$$\sum_{n=1}^{\infty} \mu_n \text{ converges [diverges]}$$

Proof:

$$(1) \quad \frac{\mu_n}{\mu_{n+1}} = \frac{n^k + b_1 n^{k-1} + b_2 n^{k-2} + - - - - -}{n^k + a_1 n^{k-1} + a_2 n^{k-2} + - - - - -}$$

[By actual division in (1)]

$$(2) \quad \frac{\mu_n}{\mu_{n+1}} = 1 + \frac{b_1 - a_1}{n} + \frac{[b_2 - a_2 - a_1(b_1 - a_1)]n^{k-2} + - - - - -}{n^k + a_1 n^{k-1} + a_2 n^{k-2} + - - - - -}$$

$$= 1 + \frac{h}{n} + \frac{Bn^{k-2} + - - - - -}{n^k + a_1 n^{k-1} + - - - - -}$$

(where $b_1 - a_1 = h$ and $[b_2 - a_2 - a_1(b_1 - a_1)] = B$)

$$\frac{\mu_n}{\mu_{n+1}} = 1 + \frac{h}{n} + \frac{1}{n^2}\left(\frac{Bn^{k-2} + - - - - -}{n^{k-2} + a_1 n^{k-3} + - - - - -}\right)$$

(3) But $\lim\limits_{n \to \infty} \dfrac{Bn^{k-2} + - - - - -}{n^{k-2} + a_1 n^{k-3} + - - - - -} = B$, and therefore is bounded

(4) Since all the conditions of Gauss' test are fulfilled it follows that:

(a) if $h = b_1 - a_1 > 1$, $\sum\limits_{n=1}^{\infty} \mu_n$ converges ($< \infty$).

(b) if $h = b_1 - a_1 \leqslant 1$, $\sum\limits_{n=1}^{\infty} \mu_n$ diverges ($= \infty$). Q.E.D.

SENSITIVITY, SENSIBILITY AND THE BALANCE

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Some texts look upon sensibility for a given load as the discrepancy between the true zero point and the rest point of a weighing caused by an excess of one milligram of weight on either of the balance pans. Others define sensibility as the reciprocal of this, namely milligrams per division displaced. Some teach both. Some use the terms sensitivity; some, sensibility; others confuse rest point and zero point. This is certainly an instructional hazard! For with regard to the definition of sensibility, the quantity it defines is in one case divided by displacement; in another case multiplied; in every event, it is interpolated.

A graphical solution of the difficulty is at the same time practical in routine weighings. The principle can be applied as well to instruments other than the balance. Determine the sensibility by any approved method. Construct a graph with displacement values as ordinate, and corresponding weights as abscissae. Plot the sensibility as determined for a given load. Draw a straight line through this point and the origin. Label it for the load in question. A family of such lines for different loads can then be constructed in a similar way. For any weighing, enter the graph at the displacement value observed and from the particular load line, read the corresponding weight. Displacements for fractions of a division can be read at the tenfold value; but the corresponding weight must be divided by ten.

Practice with such a curve soon makes the definition of sensibility and its reciprocal clear to the Freshman.

Physics

CURRENT NUCLEAR PHYSICS

William G. Guindon, S.J.

Part II

I. *Nuclear Reactions.* 2. Radioactivity

a. Apparatus

The fundamental instrument for most experimental radioactivity measurements is the Geiger-Mueller tube. Consisting of a fine wire stretched along the axis of a cylindrical metal cathode and kept at a potential about a thousand volts above the cathode, this type of counter momentarily becomes conducting when charged particles ionize the gas in it. These particles initiate the discharge by producing some of the ions and electrons directly, and the electrons in their accelerated passage to the central anode cause further ionization by collision. The multiplied effect of the original ray appears in the associated electronic apparatus as a short current pulse, or "count". Obviously the counting rate of such a tube is a measure of the rate of decay of a radioactive sample to which it is exposed; observation of the reduced counting-rate when the radiation is screened by a variable absorber gives a measure of its energy. Coincident counts in two tubes observing the same sample give evidence on the internal structure of the nuclei in the sample, especially when combined coincidence-absorption techniques are employed.

Studies have been made of the time for the ionization to spread one centimeter along the anode (1), of the "rise time" (time required for the discharge to grow to its maximum) (2), and of the "resolving time" (minimum time between distinguishable counts) (3), all of these a tenth of a microsecond or less. Some filling gases have a very marked effect on the resolving time by automatically shutting off the discharge; many studies have been made of the complicated "self-quenching" property (4), but a full understanding of it is not yet at hand.

Conventional Geiger tubes have been modified to suit various special purposes: a successful neutron counter was developed by using BF_3 for the filling gas (5) and a counter with parallel-plate electrodes has been tried out (6). The advantages of the proportional counter (in which the operating voltage is lower than in the usual Geiger-Mueller type and the size of the pulse, instead of being independent of, is now proportional to the charge of the measured particle) are urged for some types of measurements (7).[1] For certain

[1]Part I appears in THIS BULLETIN, 25, 95-101 (1948).

purposes the electron-multiplier tube is shown to be of value in replacing Geiger types (8).

Recently there has been a great deal of work probing the possibilities of a new type of counter, the crystal counter, in which the mobility of electrons inside the crystal lattice is made to indicate the passage of charged particles (9). Here a small, normally insulating crystal has parallel faces metal plated and connected across a high voltage supply. If a charged particle passes through the crystal some electrons are knocked off the atoms of the crystal and in the high electric field they move easily to the positive end of the crystal. This motion of electric charge is observed as a small current pulse in the external circuit. The most obvious benefit of this type of counter is its smallness, but crystals tend to wear out faster than other counters, and, because of space charge, need to be rested after continuous usage (10). To date, experimental counters have been constructed of diamond (11), silver chloride (12), and thallium halides (13). Recently an attempt was made to observe the same phenomenon in liquid argon, with encouraging preliminary results; liquid counters, because of the absence of space charge, will have the advantage over crystal counters in that they will not require resting (14).

Instead of measuring the conductivity pulses in crystals the production of light flashes by the impact of charged particles on certain crystals provides a different method of counting. In an effort to develop this long-used method of scintillation counting into an automatic quantitative procedure, photo-electric observation of the flashes from many inorganic crystals has been studied. Sodium iodide with some thallium impurity proves to be better than naphthalene (15); anthracene, which counts alphas, betas and gammas, is excellent (16). Scintillations have also been observed in zinc sulfide (17), and in many other inorganic crystals (18).

A fourth type of counter observes the Cherenkov radiation: the visible light emitted by a charged particle travelling with uniform velocity in a medium in which the phase velocity of light is less than the velocity of the particle (19). This condition is met in non-absorbing dielectrics, as lucite, lithium fluoride, etc. Designs have been given for lucite radiators to be used with photo-multiplier tubes, and preliminary indications are that this is a successful means for observing high energy charged particles (20). Attempts to observe this radiation with photo-sensitive Geiger-Mueller counters have not been successful (21).

The energy of radiations may be determined with counters by noting the effect of absorbers on the counting-rate, but energy determinations are more accurately carried out on various spectrometers. Beta-ray energies (and gamma-ray energies indirectly, through photo-electrons) are most easily measured by deflection in a magnetic field. In one usual type of spectrometer, the electrons move circularly in the uniform magnetic field between the poles of a large magnet; in another, electrons of one energy are focussed on a counting apparatus by the localized field of a current-carrying solenoid (magnetic lens). The focussing properties of solenoidal spectrometers have been investigated, with resulting increase in efficiency (22). Another type of instrument, used recently but of old design, is one in which the electron path is trochoidal (23). The conventional spectrometer using the focussing effect of a semi-circular path in a uniform magnetic field, has been further improved in the double-focussing type. Here the field decreases towards the edge of the pole faces; this focusses the electrons of one energy more nearly to a point, thus greatly increasing the theoretical resolving-power and intensity (24).

Gamma-ray energies can be measured indirectly on any of these instruments by using the photo-electrons ejected from suitable radiators. For very high energies a modification of the ordinary semi-circular spectrometer has been successfully used; it employs the production of positron-negatron pairs in a metal plate, the sum of the radii of their paths in a constant magnetic field giving directly the energy of the original ray (25). For direct measurement of strong gamma-ray sources a remarkable instrument has been developed: a focussing quartz crystal reflection spectrometer: it has already given results accurate to better than 0.05 percent and promises to do better than 0.01 percent (26).

Photographic techniques have become of increasing importance, partly due to the long observations needed in cosmic ray studies. It was noticed that nearly 90 percent of the tracks had faded if the exposure exceeded 20 days. This eradication of tracks, which is not without its good uses, is accelerated by the presence of hydrogen peroxide, but delayed by increased silver halide in the emulsion (27). Photographic plates have been used recently in the quantitative measuring of radioactivities impregnated in the emulsion (28), and in studying the angular distribution of alphas in scattering experiments (29). For protons the range-energy relation has been studied and account taken of the effect of a protective facing on the emulsion (30). Some more recent emulsions have been shown to be sensitive enough to record lightly ionizing particles, as electrons and mesons (31). The measurement of the energy of particles in a magnetic field has been carried out: the traces made by the particles in passing through a pair of parallel plates are measured with a projection microscope (32). A general study of the properties of photographic plates which are useful for nuclear physics has also been published (33).

b. Measurements

Measuring nuclear radioactive properties (half-life, type and energy of radiation) provides the matter for more studies than any other aspect of nuclear physics. To begin with general surveys, the energies of the beta-rays and photo-electrons from a dozen or so different isotopes have been measured in a group study using a thin-lens solenoidal spectrometer (34). Evidence of positron-negatron branching was sought in many radioactive species, but positrons were found only in Br^{80} (35). Some general coincidence-absorption surveys were applied to beta-rays and conversion (photo-) electrons (36). The angular correlation of successive gamma-rays has been investigated (37), and the production of photo-neutrons in deuterium or beryllium was used to provide a rough classification of gamma energies (38).

Special problems of general interest certainly include the search for more definite evidence for the existence of the neutrino. Measurements of the conservation of momentum in decay processes lead to the conclusion that the mass of the neutrino is certainly less than five percent of that of the electron (39), while the radioactive properties of H^3 place a theoretical lower limit of two to three percent of the electron mass (40). However, the other chief source of information, the maximum energy of beta-rays, indicates that the mass of the neutrino cannot exceed one percent of the mass of the electron (41). Also deserving of special mention are individual isotopes with peculiar characteristics. Firstly, the disputed values of the half-life and energy of the naturally radioactive K^{40} have great geophysical significance. Several papers present new measurements and calculate the effect of this isotope in producing the heat that kept the earth's surface liquid some billion years ago (42). Secondly, the energy distribution of the beta spectrum of Cu^{64} and Cu^{61} shows consistent deviation from that expected in the presently accepted Fermi theory of beta-disintegration (43). Thirdly, the alpha decay of both Li^8 and Be^8, since it really is a small-scale fission, deserves mention here (44). Fourthly, note should be taken of the search for preferential emission of alpha-rays from different faces of radioactive crystals (45), and of the unsuccessful attempt to observe the gamma-induced positron decay of the proton (46). Finally, the many theoretical and experimental studies of the disintegration of the meson should be noted, but details would involve too wide an excursion into cosmic radiation (47).

In selecting a few salient examples of radiations measured, it is convenient to follow the division of spectra into simple or complex according as the isotope emits electrons of one or more different energies. Thus an isotope emitting beta-rays of only one energy has a simple spectrum, even though the beta is followed by several gammas.

One of the isotopes with a simple beta spectrum not followed by any gamma radiation is C^{14}, important in biological studies. The long half-life (about 5000 years) has been studied and the beta energy measured exactly. Further studies concern the shape of its beta spectrum and the presence of this isotope in biological methane, due to its production from N^{14} by cosmic-ray neutrons (48). The beta energy of S^{35} has also been carefully determined and the shape of its spectrum compared with that of C^{14} (49). The total decay energy of Na^{24}, in which the beta emission is followed by gamma-rays of two energies, has been determined. Coincidence measurements, confirming this study, show that these two gamma-rays follow in cascade (one after the other), not in alternation (50). The very long half-life (interesting in such a light element) and the beta-energy of Be^{10} were studied (51). Relatively precise measurements have been made of the radiations of other isotopes of simple decay schemes: Be^7, N^{13}, K^{38}, Ca^{41}, Ca^{45}, Cr^{51}, Co^{60}, Zn^{65}, Ga^{70}, Kr^{88}, Sr^{90}, Y^{90}, Cb^{95}, In^{116}, Cs^{137}, W^{185}, Pt^{193}, Re^{187}, Os^{185}, Os^{187}, Os^{193}, Au^{198}, Au^{199}, Po^{210}, Pa^{233} (47). In addition to the rough classification of gamma energies by photo-neutron production (38), rough measurements have been made of the radioactive properties of La^{137}, Ce^{137}, I^{129}, Sm^{152}, Gd^{152}, and Bi^{210} (47).

Among the simpler kinds of complex spectra are those in which the parent isotope emits a beta ray of either of two energies, leaving the daughter nucleus in different states. Various cases of this general type have been studied: in Rh^{106} the beta-decay is either to the ground state of Pd^{106} or to one of its excited levels, from which descent to ground follows by emission of gamma quantum (52). Sc^{46} has two modes of beta-decay each of which leaves the product in an excited state (53). More complicated spectra consist of several beta energies and at least as many gamma energies. One example of this type, Sb^{124}, was formerly thought to have a less complicated decay like that of Sc^{46}, but more recent studies indicate the energies of five different betas and as many gammas (54). W^{187} apparently has only two beta-rays, one decaying to the ground state of Re^{187}, the other to a highly excited state from which the descent via gamma radiation is very complicated, at least five different gammas being observed (55). In these cases very exact coincidence-absorption methods must be used to determine the energies of the various radiations and their interrelations (the level scheme).

Coincidence-absorption studies have revealed the presence in nuclei of isomeric levels: excited levels from which the descent by gamma-emission is slow enough for half-life measurements to be feasible. Isomeric levels have been demonstrated in Tc^{99}, Sb^{122}, Sb^{124}, Te^{125}, Dy^{165}, Tm^{169}, Tm^{171}, Ta^{181}, and Re^{187}; the half-lives of these metastable states range from several months to less than a microsecond (56).

To these examples must be added the following isotopes whose spectra are complex: P^{32}, Ti^{51}, Ga^{72}, As^{72}, As^{76}, Rb^{86}, Zr^{95}, Mo^{99}, Ba^{131}, Ba^{133}, Cs^{134}, La^{140}, Sm^{153}, Eu^{154}, Hf^{181}, Ta^{182}, Re^{188}, Ir^{192}, Ir^{194}, Os^{191}, U^{237} (47).

c. Assignments

Many of the experimental studies in radioactivity concern the assignment of various activities to definite isotopes. First mention among group assignment studies belong to the demonstration of new chains of radioactive isotopes: genetically related isotopes, one being produced by the decay of another. Thus long speculation on the existence of the Neptunium (4n+1) chain has been concluded with proof. A Protactinium branch, joining the Uranium (4n+2) series at ThC′, has been artificially produced, and similar collateral branches for the Thorium (4n) and Actinium (4n+3) series, both beginning with isotopes of protactinium, have been produced in bombardments (57). Other group studies, identifying isotopes not necessarily genetically connected, concern the isotopes resulting from very high energy bombardments; instances include the isotopes of Y, Te, and I in the fission products of Pu (58), and the new isotopes produced by very high energy bombardment of Ag by alphas, of As by deuterons, and of Cu by both alphas and deuterons (59). These collision experiments were performed with the 184-inch cyclotron's 380 Mev alphas and 190 Mev deuterons. Other group studies include the mass-spectrographic assignment of nearly a dozen middle-weight isotopes (60), the study of neutron-induced activities in the rare earths (61), and the investigation of some new artificially produced isotopes of Pb, Bi, and Po (62). Similar assignments of radioactivities to isotopes of Re, Os, and Ir (63), and to those of Eu, Gd, and Tb (64) are also of a group nature.

Two important typical examples of individual assignments concern elements of 43 and 61, which do not occur in nature. Many articles treat the radiation of technetium (Tc), as element 43 is known, giving tentative or certain (as for the million year activity to Tc^{99}) assignments. Some of the radiations, though not definitely isotopically assigned, have been measured rather accurately as to energies, and tentative level schemes have been drawn up, as in the case of the activity ascribed to Tc^{95} (65). The study of prometheum (Pm), element 61, has not been so detailed, nor have so many activities been noted in it (66). Another pair of interesting assignments is connected with the fission-process: some of the products of the break-up of uranium (or plutonium) emit delayed neutrons, that is, they emit them after a measurable lapse of time after fission itself. The assignment of the 56-second delayed neutron activity to Kr^{87} and of the 23-second activity to Xe^{137} was made partly because chemical separations showed that these activities followed the chemistry of Br and I respectively (67). Other assignments gave more or less definite placement to activities in Co, Cu, Kr, Br, Se, Rb, Mo, Ru, Rh, Pd, Cd, In, Sn, Sb, Te, I, La, Ce, Pr, Sm, Dy, Ho, Yb, Lu, and Au (47). Speculation is made on the spontaneous neutron emission of Pa^{234} as a possible explanation of the presence of Pu in pitchblende (68). The activity of Sm isotopes has been discussed and the naturally-occurring alpha-radiation has been reassigned to Sm^{152} instead of Sm^{148} (69). The experimental identification of nuclear beta-emissions and atomic electrons has been achieved (70).

d. Applications

The findings of radioactivity research have found applications both practical and speculative in other parts of nuclear physics itself. The possibility of employing the high energy charged particles from a radioactive source as the power unit in an electrostatic generator has been discussed and tentative plans prepared (71). On the practical side the activation cross sections (proportional to the probability of inducing a particular kind of radioactivity in the target nucleus) of various elements for bombardment by thermal (slow) neutrons have been studied using the radioactive decay of the resulting composite nuclei in the target (72).

After biology and medicine, to which the use of radioactive materials as tracers and as sources of therapeutic radiations are very valuable, geophysics seems most interested in radioactivity research. Interest in the half-life of K^{40}, mentioned above (42), is the most prominent example: the decay period of this rare isotope may be shorter than formerly supposed, and hence at the period of the formation of the earth's crust, correspondingly more of the heat generated in the molten earth was due to potassium decay. This may necessitate the reformation of geological theories respecting the formation of mountains, etc. Geophysical interest is also aroused in the correlation between the age of the earth, or the age of elements, and other radioactivities: one study speculates on the results of an assumed preferential separation of parent and daughter elements during the period when the earth was molten (73). The thermal consequences of the capture of neutrinos by the earth have been looked into, but the conclusions are not very definite (74).

e. Theory

Recent theoretical studies of radioactivity have been of a partial nature, articles that, in general, treat of a small phase of some already established theory. The existing theories of alpha-emission have been generalized to include larger values of angular momentum (75). The theoretical interpretation of maximum beta-ray energies, and specifically the shape of the usual distribution-in-energy curve, the Kurie plot, allow one to establish limits for the mass of the neutrino (41). The electron-neutrino angular correlation was also the subject of theoretical investigation (76). A study has been made of the limits of stability against beta-decay of the whole range of the elements (77). Most of the theoretical work on gamma-radiation seems to concern angular correlations: both the angular correlation between successive radiations, either a beta-ray and a gamma quantum or two gamma quanta (78), and that between the two quanta of annihilation radiation (79) have been studied.

In addition one should mention here some notes that concern methods, but have the character of theoretical remarks. First is a paper that indicates a rapid and sensitive way of measuring the maximum beta-energy of a material, by determining the increase in counts due to back-scattering when the radiations of the sample (in the form of an extremely thin film) are counted without and with a plate of backing material (80). Another paper demonstrates a method for determining the half-lives of radioactive substances independently of counting losses (81), and one gives a means of measuring the absolute strength of radioactive sources (82).

(*To be continued*)

References

(Note. Since all the papers referred to appeared in the *Physical Review* for the years 1947 and 1948, reference will be made by indicating only the volume and page.)

(1) *71*, 646(L); *72*, 602, 784; *74*, 410, 627(L), 694(L).
(2) *72*, 477.
(3) *73*, 90(L).
(4) *72*, 243, 602; *73*, 86(L), 1131(L), 1473(L); *74*, 410, 499(L), 898, 902.
(5) *72*, 673.
(6) *73*, 1215(L).
(7) *74*, 497(L).
(8) *74*, 304.
(9) *73*, 549.
(10) *72*, 1127(L).
(11) *71*, 913(L); *72*, 643(L); *73*, 77(L), 186(L), 631(L), 1113-(L), 1467(L).
(12) *72*, 977(L), 1127(L).
(13) *72*, 1120(L).
(14) *74*, 220(L).
(15) *74*, 100(L), 628(L).
(16) *73*, 1404(L), 1405(L); *74*, 489(L).
(17) *73*, 524(L).
(18) *73*, 1210(L).
(19) *74*, 795.
(20) *71*, 123(L), 737(L).
(21) *72*, 431(L).
(22) *73*, 804(L), 1475(L).
(23) *72*, 1156.
(24) *71*, 681; *72*, 256(L), 731(L).
(25) *72*, 985(L); *74*, 315.
(26) *73*, 1392.
(27) *71*, 910(L); *73*, 634(L); *74*, 104(L), 511.
(28) *72*, 356(L); *74*, 495(L).
(29) *72*, 1176.
(30) *72*, 1121(L); *73*, 1131(L).
(31) *74*, 704(L).
(32) *74*, 507(L).
(33) *74*, 511.
(34) *71*, 321(L).
(35) *72*, 1156.
(36) *72*, 1164, 1171.
(37) *72*, 870(L).
(38) *71*, 497, 508; *72*, 902; *73*, 545.
(39) *71*, 645(L), 839; *72*, 698; *73*, 216, 809(L), 1173.
(40) *72*, 518(L); 972(L), 973(L); *74*, 699(L).
(41) *71*, 451; *73*, 1395(L); *74*, 548.
(42) *71*, 323(L), 908(L); *72*, 609, 640(L), 641(L), 1128(L); *73*, 592, 596, 916, 1209(L); *74*, 279, 831(L), 831(L), 876, 989(L), 102(L).
(43) *72*, 729(L); *73*; 259(L), 601; *74*, 227(L), 348(L), 677.
(44) *72*, 646(L); 698, 985(L); *73*, 806(L), 885; *74*, 976(L).
(45) *73*, 1474(L); *74*, 836(L).
(46) *74*, 109(L); 110(L).
(47) Cf. Volume Indices, *71-74*.
(48) *72*, 248(L), 931, 1097; *73*, 254(L), 350; *74*, 548, 696(L), 696(L).
(49) *72*, 1097; *73*, 1395(L); *74*, 548, 700(L), 847(L).
(50) *71*, 453(L); *72*, 346(L), 429; *73*, 344; *74*, 926.
(51) *71*, 269(L), 586; *72*, 591.
(52) *72*, 1049.
(53) *72*, 251(L); *73*, 141; *74*, 297.
(54) *71*, 321(L); *72*, 273, 1124(L), 1271(L); *73*, 340, 1142, 1149, 1153.
(55) *71*, 122(L), 380(L), *74*, 297.
(56) *72*, 515(L), 1271(L); *73*, 848; *74*, 728, 981(L).
(57) *72*, 252(L), 253(L); *74*, 591, 695(L).
(58) *74*, 631.
(59) *73*, 417(L), 1406(L); *74*, 347-(L).
(60) *74*, 650.
(61) *74*, 240.
(62) *71*, 552(L); *72*, 758, 766; *73*, 1211(L).
(63) *71*, 288; *72*, 730(L).
(64) *71*, 130(L), 643(L); *74*, 44.
(65) *73*, 1208(L), 1211(L), 1470-(L); *74*, 57, 220(L), 344(L), 839(L).
(66) *71*, 743(L); *72*, 85(L); *73*, 630(L).
(67) *72*, 541, 545, 567, 570.
(68) *71*, 132(L).
(69) *73*, 1125(L).
(70) *73*, 1472(L).
(71) *71*, 129(L).
(72) *72*, 888.
(73) *72*, 348(L).
(74) *74*, 621(L).
(75) *71*, 865.
(76) *71*, 456(L); *74*, 764.
(77) *73*, 16.
(78) *73*, 518(L); *74*, 764, 782.
(79) *73*, 440.
(80) *73*, 1400(L); *74*, 850(L).
(81) *71*, 1.
(82) *72*, 974(L).

BULLETIN DE LIAISON ENTRE SCIENTIFIQUES, S. J.

(Continued from page 43)

This Jesuit group is an inner unit of *l'Union Catholique des Scientifiques Francais,* an organization which includes among its members some of France's outstanding scientists, both lay and clerical, and which now collaborates with an older, similar organization in Belgium in publishing the *Revue des Questions Scientifiques.* The *Bulletin de Liaison entre Scientifiques S. J.* is a mimeographed quarterly, for Ours only, resembling the early issues of our own BULLETIN both in form and in content, which aims at providing Jesuit scientists with news and opinions on vital scientific problems, especially those related to theology and philosophy. There is this notable difference between the French bulletin and ours: while theirs is aimed at maintaining vital conflict between those who work primarily on the level of research either in pure science itself, or in scientific questions relating to philosophy and theology, our BULLETIN is intended to help also those whose apostolate centers on the use of the sciences in the classroom.

Especially after the encouraging commendation that Reverend Father General has given to the work of synthesizing scientific advance with the eternal truths, this group, not without the knowledge and approval of higher Superiors, is exploring the possibilities of widening the circle of active participants. Beside the French and Belgian Jesuit groups, beginnings have been made in Italy and in Canada; it is hoped that we will be able to cooperate too. The general objectives of this cooperative work, in their present tentative formulation, may be summed up under three headings: (1) Unified effort on common problems of research, (2) Interchange of magazines, books and reprints, and intercommunication of articles for publication in each other's journals, and (3) Formation of an inter-assistancy organization with a common journal and a general congress of Jesuit scientists, if and when these are feasible.

Today, however, the most serious obstacle to cooperative work of this kind is a mutual lack of knowledge: Ours are simply not acquainted with Jesuit scientific labors in other parts of the world. The French Jesuits would appreciate receiving from us news notices of personalities and projects in our scientific labors, so that they, through their bulletin, may inform Jesuits throughout the world of what we are doing. At the same time, they hope that we will help to publicize their work, too, among Ours, so that eventually, having been introduced to each other in this way, we may undertake to attack some of these scientific problems together. If any of the BULLETIN readers have any news releases of this sort, or any other suggestions on the matter, it would be very helpful if they would send them to the author at Weston College.

News Items

"Magnopere juverit crebro alios de aliis certeriores fieri, ac audire quae ex variis locis ad aedificationem et eorum quae geruntur cognitionem offeruntur."—Const. VIII., I.

BOSTON COLLEGE

Department of Biology

Approximately eight hundred students are taking courses in biology this semester. Courses in microbiology and comparative anatomy have been introduced to the senior classes. Twenty courses are being offered this year in biology to the various schools of the University.

A graduate department granting M.S. degrees in biology was installed in September. Fifteen full-time graduate students were accepted. All of these students assist in the College and Nursing School laboratories. Courses in general physiology, cytology, genetics, parasitology, advanced invertebrate zoology, plant physiology and histological technique were introduced this year. A course in experimental embryology is planned for next year. A seminar dealing with recent developments in various fields of biology is conducted by the faculty and graduate assistants in two periods every month. Subjects such as recent developments in chromosome structure, organizers in embryology, capillary permeability, colloid chemistry of protoplasm, experimental epidemiology, the concept of nerve fibers, protoplasmic oxidation, use of radioactive isotopes as tracers and the gene, are being discussed this term.

Dr. Bernard J. Sullivan and Rev. M. P. Walsh, S.J., have been added to the faculty after completing their doctoral studies at Fordham University. Mr. Bertram J. Smith, a candidate for the doctor's degree at Harvard University has been added as a member of the faculty.

A new physiology laboratory was installed this past summer on the first floor of the Science Building. The room formerly used for physiology was converted into a graduate school classroom and laboratory. Another room formerly the technique or supply room, is now being used as a private laboratory and study room for the graduate assistants.

A new laboratory manual for General Biology has been published by three members of the staff this Fall.

The premedical club has been reorganized with the election of officers, and meetings are held on Mondays for one period and one evening a month. Local medical men and biologists have been asked to lecture at these evening sessions. An annual banquet and other social meetings are being planned for the year.

Five of last year's seniors are working for their doctorates in biology at Northwestern, Brown, Notre Dame and Boston University. Some of the present senior class are planning to do the same thing next year.

BOSTON COLLEGE

Department of Chemistry

There are fourteen hundred students registered in the department. Of these about two hundred and fifty-eight are chemistry majors: sixty Freshman; eighty each in Sophomore and Junior; and thirty-eight in Senior. The staff consists of twelve professors, fifteen graduate assistants and twelve senior assistants. The professors are Rev. Albert F. McGuinn, S.J., in analytical chemistry and Head of the department; Dr. David C. O'Donnell in organic chemistry; Dr. Samuel Glasstone in physical chemistry, on leave with the Atomic Energy Commission for 1948-1949; Assistant Professors: Rev. Thomas P. Butler, S.J., Rev. Joseph L. Barrett, S.J., Dr. Andre de Bethune, Dr. Timothy McCarthy and Dr. Paul Maginnity; Associate Professors: Harold Fagan and Dr. Ralph K. Carleton; Instructors: Wilfred Grapes and Robert F. O'Malley; Dr. Miles S. Sherrill is Visiting Lecturer in Physical Chemistry.

For the past two years Fr. McGuinn has been a national councillor of the American Chemical Society and will continue in this office for the next three years. He has also been a member of the Council Committee on Chemical Education during the past two years.

A prominent feature in the undergraduate program has been the formation of an affiliate chapter of the American Chemical Society. After one year of existence it showed the largest membership in the country. Enthusiasm continues this year and its membership of approximately one hundred has been divided into sections according to interests: Analytic, Organic, Physical and Industrial Chemistry, Biochemistry and Food Analysis. The Food Analysis group has already undertaken a study of milk, with laboratory work done on week-ends and holidays. The entire department has signified its willingness to cooperate with these sections.

The laboratory for physical chemistry, which was set up last year, now has the benefit of additional laboratory tables so as to accommodate sixty students. Due to a large enrollment of Juniors in chemistry, increased facilities for organic chemistry became necessary. A large classroom on the first floor of the Science Building has undergone conversion so as to serve a section of eighty students for both laboratory and lecture. Interesting features include: its completion before the opening of schools on September 20; the fact that it was built by our own workmen, with exception of the sinks that had to be purchased; the fact that service lines run along the wall and that drainage is piped with galvanized iron rather than Duriron. The use of this material was dictated by its availability in time for the opening of classes. We hope to maintain it by routine flushing at the end of each day. A similar but smaller installation lasted six years before serious corrosion occurred. With exposed piping, however, repairs can be made with ease. We hope to be able to report later on its advantages and disadvantages.

BOSTON COLLEGE

Department of Mathematics

College of Arts and Sciences

This semester six elective courses are being given to Juniors and Seniors. The courses and the approximate number of students in each course are as follows:

Differential Equations	116
Advanced Calculus	30
Vector Analysis	39
Part. Diff. Eqs.	10
Math. Statistics	35
Higher Algebra	72

Higher Algebra and the Elements of Mathematical Statistics are two-semester courses; the others are one-semester courses. The revised edition of Kells' Elementary Differential Equations is found satisfactory for the course in differential equations. Statistical Procedures and their Mathematical Bases by Peters and VanVoorhis is adequate for the Statistics class. Higher Algebra by Hall and Knight is used for Algebra. Advanced Calculus by Woods and Vectory Analysis by Phillips are the other text books. The professor of Partial Differential Equations uses his own notes which are ready for publication.

Next semester there will be another Junior class and another Senior class. About 70 students will take Differential Equations. The students now in the same course will move on to Advanced Calculus. The Partial Differential Equations class will have 40 students.

The teaching staff consists of 3 Ph.D.'s in Mathematics and 10 Masters. The large staff is needed to handle the elective courses, 12 Sophomore sections in Calculus and 25 Freshman sections.

The Ricci Mathematical Academy has been reactivated. The response of the student-body is encouraging. About 175 students attend the bi-monthly meetings.

The Mathematics Library, first floor of the Science Building, is available for use from 9 a.m. to 4:30 p.m. Books may be withdrawn for a two-week period; books from the Reference Section may be taken out only overnight. There is a fine of 25 cents if the book is not returned by 10 o'clock the next morning. The books in the Reference Section are arranged according to subject matter, viz., Trigonometry, Calculus, etc. There are books on every subject being taught so that a student wishing to consult an author other than his class author need not look through the stacks but simply choose one from the proper shelf of this section which is conveniently located in a conspicuous place. The Library needs more space for study tables; the present quarters, enlarged this Summer, are still too small. The computing machine is in constant use especially by students of Statistics. A popular feature of the Library is the periodical and pamphlet rack. The pamphlets describe opportunities in Mathematics and in fields which use Mathematics.

BOSTON COLLEGE

Department of Physics

We have 821 in the physics courses, this year. Two hundred seventy-five are majoring in physics, 190 in Biology, Pre-Medical and Pre-Dental classes, 105 taking Physics courses as minor for Chemistry and Math degrees and 200 taking General Physics for their science department. Also 40 from School of Nursing and 11 in the Graduate School.

A new Acoustics Laboratory was opened this year, and the Electronics Laboratory and the Alternating Currents Laboratory were equipped for larger classes.

The Boston College Chapter of the American Institute of Physics was started last year and has over 100 members. The undergraduate joins the A.I.P. as an associate member, and when accepted may become a member of the Boston College Chapter.

CANISIUS COLLEGE

Department of Biology

Students in freshman botany at Canisius are required to present a collection of a specific group of plants dried and identified so far as possible. Most of the students collect mosses, evergreens, dicot trees or shrubs, or some other group of equivalent size, from some public area near their home, such as a large park, cemetery, or section of waste land. Many of the collections show a prodigious amount of effort, and, we hope, of interest. Collections remain the property of the college after they are handed in, and will go to augment the Canisius College Herbarium.

A collection of kodachromes of vegetational cover in distant lands is being gathered by correspondence with foreign scientists. To date, color films have been received from scientists in the Congo, in Argentina, and in Belgium. It is hoped to enlarge this collection to include photographs of all the different original vegetational covers of the world, and the department at Canisius will be glad to send unexposed color film to biologists in tropical or arctic outposts, who are willing to photograph their local vegetational cover for the collection.

J. L. Blum is working on a survey of the algae of the Niagara Frontier, and organized, during September and October, eight departmental field trips to near and distant parts of the area. Students participating in the trips collected many plants and animals, including numerous aquatic forms, since most of the field trips, being designed in part for algal collecting, lead to the outcrops of the water table.

CANISIUS COLLEGE

Chemistry Department

For the year 1948-49 the chemistry enrollment is as follows: Day School: 715 plus 150 Nurses—Total 865; Evening Sessions: Undergraduate 95, Graduate 84—Total 179; Grand Total 1044. These numbers are course students. Some students are taking more than one course.

The Program of the Alumni Chemical Society for 1948-1949 follows. October 25, 1948, Buffet Supper and Sports Night; November 15, 1948, Henry Eyring, Dean of the Graduate School and Professor of Chemistry at the University of Utah, on the Application of Modern Reaction Rate Theory to Living Systems; December 6, 1948, R. Bowling Barnes, Vice President of the American Optical Society in Southbridge, Mass., in Infrared Spectroscopy; February 7, 1949, Frederick A. Gilbert, Chairman of the Western New York Section of the American Chemical Society and Assistant to the Vice President of the Buffalo Electrochemical Co., Inc., on the Handling of Hydrogen Peroxide; March 7, 1949, Donald J. Buckley, Canisius '35, Group Leader, Esso Laboratories Chemical Division of the Standard Oil Development Co., Elizabeth, N. J., on "Butyl"; April 4, 1949, W. Conrad Fernelius, Head of the Department of Chemistry, Syracuse University on the Structure of Coordination Compounds; and, May 2, 1949, M. S. Kharasch, Professor of Organic Chemistry, University of Chicago, on Chain Reactions in Organic Chemistry.

COLLEGE OF THE HOLY CROSS

Department of Chemistry

Dr. A. VanHook has been invited by the Reinhold Publishing Co. to write an American Chemical Society Monograph on "Crystallization". He has also been invited to give papers at the International Conference of Sugar Chemists to be held in Brussels, Belgium, in the summer of 1949 and to conduct a discussion on crystallization before the Faraday Society in London during the same season. During the Spring and Summer of 1948, Dr. VanHook, T. T. Galkowski and C. F. Turner, S.J., started research on the effect of ultrasonics on the rate of crystallization. Mr. Turner's ability in electronics contributed substantially to the building of the instruments. At present he is carrying out surveys with it for his Master's degree. Dr. VanHook is also engaged in writing a monograph on sugar for the Sugar Research Foundation.

Chemistry 41 and 42 is the designation of a new course in Culture Chemistry that has been added to the curriculum this year in the form of an elective for non-science Juniors. It entails two lectures and one double laboratory period a week for a year. It has its counterparts in physics and biology, astronomy and geology. It aims at surveying matter from subatomic particles to macromolecules; at preparing the student to keep abreast of modern material developments from the front page to the stock page; and at equipping him with forms of modern thinking that are based on science and have contributed profoundly to the fabric of modern life. The course is taught by Fr. Fiekers.

The College was host to the Central Massachusetts section of the American Chemical Society on May 18, 1948. Dr. Arthur C. Cope of Mass. Inst. Tech. spoke on cyclooctatetrene. Drs. Baril and VanHook were elected officers of the Section in the business meeting. The section meets again at Holy Cross on Dec. 6 Fr. Fiekers has been appointed to the Committee of the Eleventh Summer Conference of the New England Association of Chemistry Teachers.

Our students' chemistry club, the *Cross & Crucible,* has got off to a good start again this year. The republication of the *Hormone* is just around the corner. The affiliation of the club with the American Chemical Society is also imminent.

SCIENTIFIC ANNIVERSARIES IN 1949

REV. BERNARD A. FIEKERS, S.J.

Rev. John Anthony Grassi, S.J., 1775-1849; Charles Edward Monroe, chemist, 1849 ??; Haller; Klein; Hill; Osler; Reverdin; Meldola; Kjeldahl; Albertoni; Pavlov; Daniel Rutherford; Dana; Wagner and Doebereiner. These names have been culled from the editor's notes and are published here with twofold intent: the first is by way of suggestion for contributions on a Jesuit anniversary; the second embodies the thought that the list might be of value to our professors for use in classes, seminars, science club papers, college publications and the like. The *Catholic Historical Review* for October, 1937, carries an article on Father Grassi by Fr. Gilbert Garrahan, S.J., pp. 273-292. The list is offered "sensu ajente", and it is beyond its intention to consign overlooked items to oblivion.