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of the

**American Association of
Jesuit Scientists**

Eastern States Division

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PROCEEDINGS

OF THE

TWENTY-NINTH ANNUAL MEETING

August 29, 30 and 31, 1954

HOLY CROSS COLLEGE

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OCTOBER, 1954

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Contents

Twenty-ninth Annual Meeting

Program	4
Report of the Secretary	6

Biology

Abstracts of papers read in the Biology Section	8
---	---

Chemistry

Abstracts of papers read in the Chemistry Section	11
---	----

Mathematics

Abstracts of papers read in the Mathematics Section	15
---	----

Physics

Abstracts of papers read in the Physics Section	18
---	----

Index for Volume 31	22
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Notice to Authors	(across from this page)
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Bulletin of the American Association of Jesuit Scientists

EASTERN STATES DIVISION

VOL. XXXII

OCTOBER, 1954

NO. 1

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Science and Philosophy, REV. MERRILL F. GREENE, S.J.
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Manuscripts are to be submitted to associate editors of the appropriate section and may be submitted directly to the editor in chief. Clear manuscript, preferably typed, with wide margin to the left, with double spacing between lines, is desirable. Please try to follow the typographical style of the most recent issue of the BULLETIN. Line drawings should be submitted on Bristol board, or similar material, and done in India ink. Figure number should be written on this in pencil. Titles for drawings, with figure numbers, should be typed on a separate sheet. Please try to minimize footnotes. Appended references and bibliographies, clearly so marked, should be done in the style of the A.A.A.S. publication, *Science*.

Program

Twenty-ninth Annual Meeting
of the
AMERICAN ASSOCIATION OF JESUIT SCIENTISTS
EASTERN STATES DIVISION

HOLY CROSS COLLEGE

August 29, 30 and 31, 1954

FIRST GENERAL MEETING

Sunday August 29, 1954 at 7:30 P.M. in Alumni Hall

Address of Welcome

Very Rev. William A. Donaghy, S.J.
President of Holy Cross College

Business meeting

PRESIDENTIAL ADDRESS: The Atmosphere

Rev. Thomas J. Smith, S.J.

MEETINGS OF THE SECTIONS

BIOLOGY SECTION

Biliary Secretion by Spontaneous and Induced

Hepatomas in the Mouse

John W. Flavin, S.J.

The Effects of Adrenal Extracts on Hemopoiesis in

the Kidney of the Tadpole of *Rana Pipiens* with

Special Emphasis on Eosinophils

Rocco G. Belmonte, S.J.

Some Aspects of Low Temperature Research

in Alaska

Joseph B. Hanzely, S.J.

Recent Trends in Bacterial Cytology and Genetics

Michael P. Walsh, S.J.

Evolution and the Scientist

George L. Drury, S.J.

Philosophical Implications of Biology

Anthony J. MacCormack, S.J.

Objective and Methods in Teaching the

Biological Sciences

George F. Lawlor, S.J.

Evolution and the Theologian

Alwyn Harry, S.J.

CHEMISTRY SECTION

Precipitation from Homogeneous Solution; An Analytical Procedure	Lawrence O'Toole, S.J.
The Thermal Decomposition of Hydrocarbons	Robert Cloney, S.J.
The Mechanism of Free Radical Reactions	Robert Varnerin, S.J.
The Historical Approach to Chemistry	Bernard Scully, S.J.
A Qualitative Determination of the Degree of Silicosis	Charles Thoman, S.J.
The Electro-analysis of German Silver for Copper and Nickel	Gerald F. Hutchinson, S.J.
The Analysis of Silicate Rocks	Albert F. McGuinn, S.J.
Chemical Applications of Iso-electronic Structures	Bernard A. Fiekers, S.J.
Course in Radioactive Tracers by Tracerlab	William J. Schmitt, S.J.
Theories of Ion-Exchange	James Cowgill, S.J.

MATHEMATICS SECTION

Introduction to the Theory of Numbers	Stanley J. Bezuszka, S.J.
Dirichlet Series	John MacDonnell, S.J.
Methods of Teaching Solid Geometry	Richard Harper, S.J.
Hyperboloids of One Sheet	Robert Canavan, S.J.
Inverses of Matrices	John Green, S.J.
The Logarithm	Charles Lewis, S.J.
Effective Processes	Walter Feeny, S.J.

PHYSICS SECTION

The Strong-focussing Synchrotron (<i>Chairman's Address</i>)	William G. Guindon, S.J.
Observations on the Secondary Maximum of the <i>Nova T Coronae Borealis</i>	Martin F. McCarthy, S.J.
	William R. Callahan, S.J.
The Ebert Spectrograph	James J. Devlin, S.J.
Precision Measurements of Wavelengths and Intensities	M. Thekaekare, S.J.
On Allowed and Forbidden Bands for Wave Propagation in Crystals	James J. Ruddick, S.J.
Molecular Collision Diameters by Microwave Spectroscopy	Francis A. Liuima, S.J.
The Geology of the Weston, Massachusetts Area	James W. Skehan, S.J.
The Origin of Terrestrial Magnetism	Frank R. Haig, S.J.
The Structure of a Physical Theory	Edward M. MacKinnon, S.J.
Secondary School Science Fairs	Joseph L. Murray, S.J.

FINAL GENERAL MEETING

Tuesday, August 31st at 9:30 A.M. in Alumni Hall

Report of the Secretary
Report of the Committee on Resolutions
Report of the Committee on Nominations
Election of Officers

SECRETARY'S REPORT

FIRST GENERAL SESSION

The twenty-ninth annual meeting of the AMERICAN ASSOCIATION OF JESUIT SCIENTISTS, Eastern States Division was called to order by Father Thomas J. Smith, the President, at 7:40 P.M. in Room 24 of Alumni Hall of the College of the Holy Cross, Worcester, Mass.

In the absence of Father Joseph Mulligan, the Secretary of the Association, Mr. James J. Ruddick, S.J. was appointed acting Secretary.

Father Smith introduced Father William A. Donaghy, President of Holy Cross College. Father Donaghy cordially welcomed the members of the Association and spoke briefly of the great opportunity for the Jesuit science teacher to relate his work to God and, even more, to teach by his example as a scientist and teacher.

The minutes of the previous meetings held at Philadelphia were approved as printed in the BULLETIN. Father Smith then appointed the following committees:

Committee on Resolutions

Rev. Michael Walsh
Rev. George Hilsdorf
Rev. Paul McNally

Committee on Nominations

Rev. Clarence Schubert
Rev. Edward Hauber
Rev. Anthony MacCormack

Announcement was made by the President of the decisions of the Executive Council with regard to the election of new section chairmen in the Mathematics and Physics sections. It was also announced that Regents whose major assignment is in science or Mathematics are approved as new members of the Association. Others not falling in these categories yet wishing to be members may apply directly to the President.

The Presidential address was delivered by Father Smith. For his topic he chose "The Atmosphere," discussing its composition, properties and temperature variations at different levels as well as the influence of the various layers in the atmosphere on our weather.

The meeting was adjourned at 8:35 P.M.

FINAL GENERAL SESSION

The final general session was called to order by Father Smith at 9:35 A.M. on August 31, 1954. Father John McCarthy, editor of the BULLETIN asked all who had given papers to forward, as soon as possible, an abstract for publication in the BULLETIN. He also urged the continued co-operation of the members in contributing articles for the BULLETIN.

Father James Skehan then read a report to the meeting on the progress within the past year of the Weston Science Colloquium.

The secretaries of the various sections were then asked to report on the election results. They were:

Physics	Chairman—Rev. Robert MacDonnell Secretary—Mr. Frank Haig
Mathematics	Chairman—Rev. John Caulfield Secretary—Mr. Walter Feeny
Biology	Secretary—Mr. Richard Fahey

The report of the resolutions committee was presented by Father Walsh:

1. Be it resolved that the members of the American Association of Jesuit Scientists (Eastern States Division), present at the twenty-ninth meeting, express their sincere thanks to Rev. William A. Donaghy, Rector of Holy Cross College; to Rev. Bernard R. Boylan, Minister, and to the Community of Holy Cross College for their warm welcome and very generous hospitality.
2. Be it resolved that the members express their gratitude to Rev. Thomas J. Smith, to Rev. James K. Connelly and Rev. Bernard A. Fiekers for their efforts in making this a successful convention.
3. Be it resolved that the Association express its appreciation for the work of Rev. John McCarthy as Editor-in-Chief of the BULLETIN and to Rev. Edward B. Berry for his continual and long service as Treasurer of the Association.
4. Be it resolved that the members of the Association be informed of the death of Rev. Joseph A. Assmuth who died in Germany last June and who is recommended to the prayers of all members of the Association. Father Assmuth, internationally known for his work in Entomology and also as a beloved teacher of some of our present members, will long be remembered for his friendliness and enthusiasm at our annual meetings. May the soul of this departed member rest in peace.
5. Be it resolved that the Secretary of the Association be instructed to send a copy of these resolutions to the Reverend Father Rector and Father Minister of Holy Cross College and a copy of

the resolution on Father Assmuth to the Reverend Provincial of the German Province.

Respectfully submitted,

REV. MICHAEL P. WALSH, *Chairman*
REV. GEORGE J. HILSDORF
REV. PAUL A. McNALLY

Father Clarence Schubert then gave the report of the committee on nominations at the request of the President. They were:

President—Rev. George Hilsdorf

Secretary—Rev. George Drury

Treasurer—Rev. John O'Connor

All were unanimously elected.

Father Hilsdorf took over the chair and spoke briefly of next year's meeting, tentatively set for Fordham. With no further business to be transacted the meeting adjourned at 10:15 A.M.

Respectfully submitted,

JAMES J. RUDDICK, S.J.
Acting Secretary

Biology

THE EFFECTS OF ADRENAL EXTRACTS ON HEMOPOIESIS IN THE KIDNEY OF THE TADPOLE OF *RANA PIPIENS* WITH SPECIAL EMPHASIS ON THE EOSINOPHILS

(Abstract)

ROCCO G. BELMONTE, S.J.

The purpose of this study was to ascertain the effects of cortisone, cortisone acetate, ephedrine sulphate and epinephrine bitartrate on the process of hemopoiesis in the kidney of the tadpole of *Rana pipiens*. It was hoped that further information might be obtained on the rôle played by the endocrines in relation to blood-cell formation in cold-blooded animals. The emphasis on eosinophil formation seemed warranted in view of recent findings indicating that eosinophils in the peripheral blood are sensitively affected by adrenal factors.

The normal hemopoietic activity of the mesonephros or tadpole kidney had not previously been described from a study of sectioned material and an attempt was made to do so in this investigation. The

observations were limited to the kidney of the premetamorphic and early postmetamorphic tadpole. The blood-forming tissue of the mesonephros appeared to be granulopoietic. Neutrophils, eosinophils, monocytes, large hemoblasts (hemocytoblasts) and small hemoblasts were present in considerable numbers but there was a predominance of neutrophils. Thrombocytes and basophils were not found in the hemopoietic tissue proper and no evidence of erythropoiesis was observed outside the blood vessels or sinuses.

Differential blood cell counts were limited to the mesonephroi of animals exposed to treatment for four days and of animals treated for twenty-four days. Except for a relatively marked decrease in the number of neutrophils in the cortisone acetate-treated group very little change was observed in the differential counts. Blood counts of eosinophils were made for all the stages in the experiments. Observations of these counts indicated that only cortisone acetate, and possibly cortisone, had any significant effect on the numbers of eosinophils in the tadpole kidney. The response to cortisone acetate was as follows: the eosinophil level remained normal for the first eight days, then decreased gradually for the next twelve days and thereafter returned to normal. The eosinopenia due to cortisone treatment followed a similar pattern but was less noticeable. Ephedrine sulphate and epinephrine bitartrate produced no significant changes in the hemopoietic tissue.

BACTERIOLOGICAL CYTOLOGY AND GENETICS

(Abstract)

MICHAEL P. WALSH, S.J.

These two branches of biology have undergone their greatest development during the last century. Progress in these two fields has been due to the discovery of new techniques and the application of methods widely used in other branches of biology to a study of the bacterial cell. Although a variety of theories has been proposed to explain the nature of the bacterial nucleus, the majority of investigators today maintain that bacteria have discrete and distinct nuclei with one, two, or three chromosomes and some have reported the presence of true mitosis. In genetics, almost all geneticists and bacteriologists support the theory that variations in bacteria are due to mutations and selection and not to adaptation as some have held in the past. The fluctuation test of Lederberg and Delbruck is the usual method used to prove this. Streptomycin resistance in bacteria follows a different pattern than resistance to other antibiotics. A knowledge of genetics of bacteria has had a strong influence on other aspects of bacteriology. Problems in therapy, metabolism, taxonomy and evolution have been aided through an expanding knowledge of the genetics of bacteria.

EVOLUTION AND THE SCIENTIST

(Abstract)

GEORGE L. DRURY, S.J.

In recent times a most significant contribution to evolutionary theory has come from studies in population genetics. The importance of these studies lies in the attention focused upon genes in the natural circumstances of large interbreeding groups. As a result of work done in this field new understanding of the problems of riation and speciation have been brought to light. Large scale changes on the evolutionary scene are explained only if many factors are considered, principally mutation together with the process of sexual reproduction, the size and breeding structure of the population and the influence of such forces as natural selection, genetic drift and isolation.

EVOLUTION AND THE THEOLOGIAN

(Abstract)

ALWYN HARRY, S.J.

This paper dealt with the pronouncements of the Pope during the past fourteen years on the subject of Evolution, and also the opinions of outstanding Theologians, Philosophers and Scientists during this period. The purpose of the paper was to show that Reason and Faith do not at all exclude one another but that, very much to the contrary, when both are genuine, they confirm each other.

The paper concluded with an excerpt from a recent article by Rev. Albert L. Schlitzer, C.S.C., Ph.D., S.T.D.:

"The sources of information for the theologian touching on the question of the evolution of man urgently call upon the theologian to be cautious and at the same time to have an open mind. Caution is dictated because the question involves the proper interpretation of the sacred word of God

Note: This paper is substantially the same as that which appeared in the March issue of this BULLETIN, under the title, "A Commentary on Evolution." However, there were a few additions and alterations made in the paper for its presentation at the Science Convention, under this title, "Evolution and the Theologian." To the Bibliography which appeared in the March Issue of the BULLETIN should be added the following:

Pius XII. Address to Pont. Acad. of Sciences, AAS, 44 (1952), 31 ff.

Philip S. Fothergill, *Historical Aspects of Evolution*, London, Hollis and Carter (1952).

Albert L. Schlitzer, C.S.C., "The Position of Modern Theology on the Evol. of Man," *Laval Theologique et Philosophique*, 8 (1952), 208-229.

Pere A. Brisbois, S.J., "Transformism and Philosophy," *Theology and Evolution*, edit. E. C. Messenger, London: Sands and Co., Ltd. 1952.

E. C. Messenger, "Evolution and Theology Today: A Re-examination of the Problems," *Theology and Evolution*, London: Sands and Co., Ltd. 1952.

which is not to be tied to whims and unfounded opinions, and because the problem affects dogmatic truths such as Original Justice, Original Sin and Redemption. The sources dictate an open mind, too, because the theologian in his search for truth cannot without harm to his own work disdain the help of genuine science.

"If scientific research gives solid reason for modifying somewhat the picture of Adam such as Tradition has handed down, and to which we are accustomed in our thinking, let us heed the voice of the Holy Father and not reject the new just because it is new. In such an event science will prove to be the true handmaid of theology helping the queen of the sciences to understand better its own sources."

Chemistry

PRECIPITATION FROM HOMOGENEOUS SOLUTION

(Abstract)

LAWRENCE O'TOOLE, S.J.

Precipitation from an homogeneous solution is caused by a critical change in concentration due to the slow hydrolysis of a dissolved compound, so that the changing concentration is the same throughout, and not initially localized by the addition of an external reagent. Practical laboratory advantages of such a method are demonstrated by several determinations based on the hydrolysis of organic reagents.

The slow and uniform hydrolysis of urea to ammonia causes an homogeneous increase in pH which slowly precipitates aluminum basic sulfate from an initially acidic solution of aluminum and sulfate ions. The quality of the precipitate is contrasted with that obtained by external addition of ammonium hydroxide under optimum conditions.

Methods for determining barium, strontium, and calcium as sulfates by the hydrolysis of dimethyl sulfate eliminate several difficulties of the usual procedure. The formation of a coarse, dense precipitate which is relatively free from contamination is obtained by this faster and simpler procedure.

Two different methods of precipitating cations as oxalates from homogeneous solutions demonstrate the wide scope and adaptability of the general method of precipitation by hydrolysis.

This general method is also used to separate and determine the rare earths, thorium, zirconium, and hafnium.

It should be noted that there would be a considerable pedagogical value in introducing an experiment of this type into the quantitative analysis course since a single experiment highlights and correlates the basic concepts of hydrolysis, pH regulation, ionic equilibria, and the von Weimarn ratio.

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7. Willard, H. H., and Hahn, R. B., *ibid.*, **21**, 293 (1949).
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THE THERMAL DECOMPOSITION OF HYDROCARBONS

(Abstract)

ROBERT D. CLONEY, S.J.

This paper was presented as an introduction to the work done by Robert E. Varnerin at Catholic University on the mechanism of the thermal decomposition of ethane. In 1936 a general method for detecting the presence of free radicals in a reaction system was devised which employed the use of nitric oxide. It was found that small amounts of this substance would in many cases bring about considerable reductions in the rates of organic reactions. It seemed that nitric oxide reacted with and in some manner destroyed the free radicals in the system. Investigators assumed that free radicals played no part in the completely inhibited reaction. After further investigation by other men a number of different mechanisms were advanced for the residual reaction, many of which involved free radicals. Mr. Varnerin extended these investigations and concluded that the molecular mechanism of the completely inhibited reaction was insignificant.

THE MECHANISM OF THE THERMAL DECOMPOSITION OF ETHANE¹

(Abstract)

ROBERT E. VARNERIN, S.J.

Ethane may decompose (a) according to a free radical mechanism in which the ethane molecule splits initially into two methyl radicals



¹This paper is based on research carried out at Catholic University.

followed by a series of free radical reactions in which the products of the decomposition, ethylene and hydrogen, are formed or (b) according to a molecular reaction



in which a hydrogen molecule is separated from the ethane molecule in a single elementary step. Since nitric oxide inhibits the rate of decomposition to a definite limiting rate, it has been disputed for many years whether the decomposition is entirely free radical or a combination of free radical and molecular decomposition. Isotopic tracer technique has been applied to the problem. Ethane-d₆, C₂D₆, has been decomposed in the presence of methane, CH₄. By mass spectrometric analysis the extent of isotopic mixing, which is due to free radical reactions only, was determined on the basis of the CH₃D/CH₄ ratio. For a fixed fractional decomposition of ethane this ratio is independent of the presence of nitric oxide. This indicates that the thermal decomposition of ethane is a free radical reaction in which there is negligible molecular decomposition present. A probable explanation for the nitric oxide inhibition has been proposed.

A QUANTITATIVE DETERMINATION OF DEGREE OF SILICOSIS

(Abstract)

CHARLES THOMAN, S.J.

This paper is a report on a research project being conducted at the University of Scranton. Some time was spent in tracing the historical background of the project from a sociological angle. Such a method is needed to discriminate between silicosis and tuberculosis, which medically have a like diagnosis in the first and second (curable) degrees; in such a way, some definite basis for rightful compensation will be afforded the affected miners, and at the same time they will be sufficiently warned to take precautionary measures before the disease reaches the third (incurable) degree.

The method is essentially that of Gettler and Umberger, both of New York University, as reported in the *American Journal of Clinical Pathology*, (9, 1, 1945), and provides for the determination of silica content of tissues colorimetrically in the presence of phosphates. To provide a standard, five gram samples of normal sputum, and varying amounts of a standard silicate solution made up in such a way that one ml is equivalent to one mg of silica are weighed in a platinum crucible, ashed and ignited to remove carbon. Then, 2.5 g of a Fusion Mixture of equal weights of potassium and sodium carbonates are added to dispose of calcium and iron as insoluble carbonates. After solution in hot water and filtration, the filtrate is acidified with acetic acid and heated to expel excess carbon dioxide. Twenty

ml of ammonium molybdate are added, which changes the phosphates to molybdyphosphoric acid, and the silicates to molybdysilicic acid, both soluble and pale yellow in color. After twenty minutes, oxalic acid is added to protect the molybdyphosphoric acid during the subsequent reduction. After ten minutes, ten ml of a solution of 0.75 g hydroquinone and ten g sodium sulfite in 100 ml water are added; this reduces the Molybdysilicic acid to Molybdynum Blue. Thirty minutes are allowed for the maximum blue color to develop, and the solution is diluted to 200 ml and tested colorimetrically in an electrophotometer using a No. 525B filter.

The "A-scale" readings thus recorded were plotted against the mg of silica in the solution to give the standard graph. The extinction value of 0.054, obtained when no standard silicate solution was used, represents the amount of silica in normal sputum and the value was subsequently subtracted from other "A-scale" readings to give the readings for excess sputum, which is the quid petium.

In testing diseased sputum, the method is changed only in that no standard silicate solution is added. The degree of silicosis is first determined as accurately as possible by the inadequate standard methods by a local doctor, and their sputum then tested by us for silica content. Though the project is still in the preliminary stages, an encouraging trend seems to be developing: thus far, first degree would seem to contain between 20 and 35 ppm of silica; second, between 35 and 90 ppm; and third, above 90 ppm. By contrast, normal sputum contains approximately two to five ppm.

It now seems that the project, which up to now has been private work of the University, will be subsidized by the United Mine Workers and Franklin Medical School of Philadelphia, with whom we will work.

CHEMICAL APPLICATIONS OF ISO-ELECTRONIC STRUCTURES

(Abstract)

B. A. FIEKERS, S.J.

Carbon monoxide and nitrogen are iso-electronic structures; fourteen electrons are found in each. The pharmacological similarity of ether oxygen and its analogy to the secondary amine group is also notable. Derivatives of borazole parallel those of benzene in physical properties, and boron nitride does not differ greatly from graphite. Aluminum phosphate, AlPO_4 , considered as AlO_2^- , PO_2^+ , is analogous to $(\text{SiO}_2)_{2n}$ and has the tetrahedral structure of quartz. By similar reasoning, the structure of the fluoiodate anion can be correlated with that of tellurium tetrachloride; namely bipyramidal with an open position in the equatorial plane. Other correlations include some of the interhalogen compounds, such as IBr_3 , the alkali silicates and related structures and the recently elucidated general structure of glasses.

Mathematics

DIRICHLET SERIES

(Abstract)

JOHN J. MACDONNELL, S.J.

A Dirichlet series is a series of the form:

$$(1) \sum_{n=1}^{\infty} a_n e^{-\lambda_n z}$$

where (a_n) is any sequence of numbers; (λ_n) is a sequence of real numbers increasing monotonically to infinity; $z = x + iy$ is a complex number.

Since the terms of (1) as exponential functions are analytic in the whole plane, (1) represents a function, $f(z)$, analytic and regular in every region, D , in which (1) converges uniformly.

The series (1) was introduced by Peter Dirichlet in a paper in which he applied the theory of analytic functions to the solution of problems in analytic number theory.

The region of conditional convergence of (1) is a half plane, (or the whole plane, or the empty set), as is the region of absolute convergence, and the region of regularity of the sum function, $f(z)$. These three half planes, however, are not always identical. In this respect a Dirichlet series differs from a power series, since in the latter the circle of convergence, the circle of absolute convergence, and the circle of regularity of the sum function are identical. There is, however, a more essential difference between a Dirichlet series and the simpler power series. The region of convergence of a power series is determined in the simplest possible manner by the disposition of the singular points of the function which it represents: the circle of convergence extends up to the nearest singular point. A Dirichlet series, however, which is convergent in a portion of the plane only may represent a function regular over the whole plane, or in a wider region of the plane than the region of convergence of the series.

METHODS IN TEACHING SOLID GEOMETRY

(Abstract)

RICHARD HARPER, S.J.

The traditional form of presenting theorems as found in the standard texts on Solid Geometry consistently follows the pattern of stating the antecedent and then all the steps necessary that are neces-

sary to arrive at the consequent. But as an aid to a more meaningful approach on the part of the student, it may be helpful if the teacher were to present those theorems, in which the antecedent is a sufficient and necessary condition for the consequent, by beginning the proof with the statement of the consequent and reasoning "back" through the steps necessary to prove the consequent and thus arrive at the necessary antecedent(s). This would conform to the method usually followed in solving geometry problems and would thereby establish a closer relation between the thought processes employed in doing theorems and problems in Solid Geometry.

INVERSE OF MATRICES

(Abstract)

JOHN GREEN, S.J.

The paper treated of four methods usable in finding inverses for matrices. Methods employed were those of using the adjoint of a determinant, a formula, a linear system and reduction to an identity matrix.

THE LOGARITHM

(Abstract)

CHARLES LEWIS, S.J.

In his published lectures: *Elementary Mathematics from an Advanced Standpoint*, Felix Klein has many a fine pedagogical insight to reward the teacher who is on the watch for new and better approaches to his subject. In his section on the logarithmic and exponential functions, Klein criticizes the "algebraic" account of these topics as found in the ordinary school books. Moreover, the formal analytic approach to the topics is often quite unmotivated. There is a definition of the "natural" base; there is a definition of the log as a definite integral. But the student may well be perplexed as to the "naturalness" of e as a base; and the elaborate precautions taken to define the log as a definite integral may strike him as just so much pedantry and fuss.

Klein very cleverly leads us through the developments of Napier and Bürgi. Both men had the insight of genius to seek a base, b , for the exponential equation $x = b^y$, so that, for integral increments of y , the corresponding values of x would be sufficiently close for the ordinary margins of accuracy required in logarithmic computations. With an appropriate shift of scale of the increment of the y ordinate, both Napier and Bürgi are seen to have used the difference equation

$$\frac{\Delta y}{\Delta x} = \frac{1}{x}$$

with the corresponding sum for the logarithm

$$y = \sum \frac{\Delta P}{P}$$

The decisive step of taking the limit of this sum is now well motivated in its historical context. Moreover, the shift of base, involved in the limit process, brings us face to face with the number e in an atmosphere of familiarity, almost expectation. Indeed, Bürge's base, properly scaled, agrees with e to three decimals.

Perhaps Klein's presentation of the logarithm could not be followed in the high school classes; but if the college freshmen were exposed to it, a breath of fresh air would relieve the stifling boredom with which they march through their tedious and unmotivated computations. They would begin to see that mathematical insight and understanding are so different from computational skill. And those students who went on through the Calculus could meet the logarithm later in its analytic formulation with a smile of recognition.

EFFECTIVE PROCESSES

(Abstract)

WALTER J. FEENEY, S.J.

The notion of an algorithm or effective process, encountered in practice throughout mathematics beginning with our first acquaintance with arithmetic, is intuitively understood by all. An algorithm, such, as the process used in long division of integers, is recognized as a perfectly effective procedure which will yield in a finite number of steps the quotient of any two integers.

To prove the existence of an algorithm for disposing of some problem, such as long division, one merely exhibits the desired algorithm by describing the procedure to be followed in order to arrive at an answer. This procedure will consist of writing and recognizing symbols of some fixed set according to well determined directions until a direction is encountered which tells us that we are to stop and how we are to read off the answer from the symbols we have written.

To prove the non-existence of an algorithm for solving some problem requires an exact formalization of our intuitive notion of an algorithm. Modern mathematics has furnished several such formalizations, all of which have turned out to be equivalent. One such is the Truing machine, a machine conceived to imitate any possible behavior of a human computer. Whether such a machine actually does formalize satisfactorily the intuitive notion of an algorithm must be decided on heuristic evidence.

Physics

THE STRONG-FOCUSSING SYNCHROTRON

(Abstract)

WILLIAM G. GUINDON, S.J.

The synchrotron, in which both magnetic induction, B , and oscillator frequency, f , are varied, provides the highest energies currently available in particle accelerators. Focussing of the beam is achieved by shaping the magnetic field so that it is radially decreasing outwards at the outer edge. Courant, Livingston and Snyder¹ have shown that a magnet formed of alternating sectors of radially decreasing and increasing magnetic field will focus a beam much more sharply than the conventional type. Lindquist² has extended their calculations to include the effect of the straight gaps common to present-day proton synchrotrons. Several strong-focussing proton synchrotrons of this alternating gradient design are projected for construction in the energy range 15-25 Bev.

OBSERVATIONS OF THE SECONDARY MAXIMUM OF *T CORONAE BOREALIS*

(Abstract)

MARTIN F. MCCARTHY, S.J., AND WILLIAM R. CALLAHAN, S.J.

The present paper gives a preliminary report on observations of the secondary maximum of *Nova T Coronae Borealis* (1946). Thirty plates covering this phase of the light curve (May 30, 1946—Sept. 26, 1947) were obtained with the three-inch Ross Camera (21" focal length) at Georgetown College Observatory. These plates plus ten others used in standardizing the stars in the Corona Borealis Field were taken by Fr. Francis J. Heyden, S.J., and the Georgetown observers including Fr. L. C. McHugh, S.J., Mr. William Dix, Mr. William Devereux, and Mr. Martin F. McCarthy, S.J.

Observations of the Nova were added to the regular program at Georgetown because of the peculiar shape of the light curve displayed by this star at its previous explosion in 1866. Exposures on the Nova Field and on the Standard Field containing the North Polar Sequence were made on Kramer Hi-Speed (blue-sensitive) plates; because of the brightness of the Nova, 15-minute exposures proved

¹ *Phys. Rev.* **88**, 1190 (1952).

² *Phys. Rev.* **91**, 981 (1953).

sufficient. The customary procedures of photographic photometry were followed in determining the magnitudes of the comparison stars and corrections for the effects of distance, color, and extinction were applied. The Argelander step-method was employed in estimating the magnitude of the Nova on each of the available plates.

The measurements of the secondary maximum of *T Coronae Borealis* were made originally at Georgetown by one of the authors (1). These measurements have been repeated and checked at Weston College as an introductory exercise in photographic photometry by the other author. Final reductions, when completed, will be published. Our present data show that *T Coronae Borealis*, after rising from its pre-nova stage (11.2 mag.), to its observed maximum of 3.2 mag., dropped within 100 days to a value near 10.0 mag., then rose slowly to 8.2 mag. before beginning its final "fade-away." Observations made at Georgetown in Sept. 1947, some nineteen months after the initial expansion, indicate that the Nova had reached a magnitude of 10.6. Further details will be presented later.

It is a pleasure to acknowledge with gratitude the kindness of Fr. Francis J. Heyden, S.J. of Georgetown who directed these observations and sent the plate collection to Weston College for the present measurements. Our thanks also to Fr. James E. Coleran, S.J., Rector of Weston College, Fr. Paul T. Lucey, S.J. and Fr. Henry M. Brock, S.J. for the help and encouragement given us in carrying out this little project at Weston College.

REFERENCE

1. JESUIT SCIENCE BULLETIN, 23, 74 (1946).

ALLOWED AND FORBIDDEN BANDS FOR WAVE PROPAGATION IN CRYSTALS

(Abstract)

JAMES J. RUDDICK, S.J.

For the understanding of much of current solid state research, a knowledge of wave propagation in crystals is very important. It is of great help to study first one-dimensional lattices and their properties. Solutions for waves propagated in lattices with nearest neighbor interaction and in lattices of the Born (NaCl) type are of special interest. When plots of frequency *vs.* wave number (reciprocal wavelength) are examined from the points of view of velocity of propagation, allowed and forbidden regions, and attenuation factor, many interesting results appear.

Two-dimensional lattices require the use of reciprocal lattices. In general, a periodicity of the frequency (plotted in reciprocal space) corresponds to a periodicity of the medium of propagation (plotted in ordinary space). Brillouin zones for allowed propagation are easily drawn for this two-dimensional situation. For three dimensions, as in real crystals, the generalization is readily made from the previous case.

Three-dimensional Brillouin zones have been important in recent studies, as for instance, the calculation of scattering of electrons traveling through semiconductor crystals and the improving of calculations of energies in crystals by means of LCAO techniques.

THE ORIGIN OF TERRESTRIAL MAGNETISM

(Abstract)

FRANK R. HAIG, S.J.

The origin of terrestrial magnetism remains a problem for modern science. Historically, three solutions have been offered to resolve it: a ferromagnetic theory basing terrestrial magnetism of ferromagnetic deposits within the earth, an electromagnetic theory crediting geomagnetism to a globe-encircling current within the earth, and a gyromagnetic theory attributing the field to the earth's rotation. Today the first is rejected because of the supposed high internal temperature of the earth's core the second because of a lack of an agent to start and maintain such a current, and the third on the basis of recent experimental findings. The problem still remains.

THE STRUCTURE OF A PHYSICAL THEORY

(Abstract)

EDWARD M. MACKINNON, S.J.

Modern scientific theories with their complex symbolism and highly formalized structure are difficult to understand and interpret. As an aid to comprehension many scientists have made a detailed study of the nature of scientific theory itself.¹ Here we will summarize a few of their more basic conclusions.

Classical physics, (e.g., Newtonian mechanics), has the general structure of a deductive system. General laws, or hypotheses ($F = ma$) are applied to special cases (a taut string) to give secondary hypotheses, which give more detailed information about a more restricted field. By specifying the constants in the resulting equation, a numerical result is obtained.

Verification. The general hypotheses are tested in an indirect way by checking the numerical conclusions drawn from them with

¹ A rigorous study of the structure of a scientific theory is to be found in Richard Braithwaite, *Scientific Explanation: A Study of the Function of Theory, Probability, and Law in Science* (Cambridge Univ. Press, 1953). Various aspects of this general problem are treated in: Philip Frank, *Modern Science and Its Philosophy* (Cambridge, Mass. 1950), which contains a good historical account of the early modern movements in the philosophy of science, pp. 1-52; Henry Margenau, *The Nature of Physical Reality: A Philosophy of Modern Physics* (New York, 1950); A. S. Eddington, *The Nature of the Physical World*, (New York, 1933); D'Abro, *The Rise of the New Physics: Its Mathematical and Physical Theories*, 2 vols. (Dover Publications, 1951); and P. W. Bridgman, *The Logic of Modern Physics* (New York, 1927).

experimental results. If the two do not check the general hypothesis must be considered wrong; or, as is more generally the case, the collection of principles on which the theory is based must be modified by a trial and error method, if possible. If predicted results and experiment consistently check, the theory is considered to be, not proven, but probable. That is, the physical hypothesis does not necessarily state the true nature of things, but it is a safe principle from which to draw conclusions. If different hypotheses give the same mathematical results, the hypothesis which is accurate over a wider range is generally to be preferred, at least as far as this norm is concerned.

Modern physics has introduced two important changes in this general structure. First is the emphasis on *operational definitions* introduced by Bridgman and based on the work of Einstein. Through the analysis which led to special relativity, Einstein saw that, for a physicist, the meaning of the term "simultaneity" was dependent upon the operations by which the time and space separation of two events was measured. It was quickly realized that, in a science based on measurement, operational definitions are necessary for logical consistency.

Quantum mechanics, especially the Heisenberg indeterminacy relation showed that there was a definite limit in the accuracy attainable in measurement. Since the fundamental hypotheses are based on measurement by means of operational definitions this indeterminacy must appear in the general laws, or hypotheses, of physics. Thus the basic laws of quantum mechanics are probability relations rather than equations which give an exact representation of the behavior of individual particles.

"*Constructs*" is the term introduced by Margenau to lump together the terms and concepts with which the theoretical physicist is concerned. Some terms, e.g., electrons, temperature, apparently correspond to very definite aspects of reality. Others, entropy, or the psi-function have a more indirect or dubious connection. Yet both types stand on the same footing in a physical equation. This indicates that the physicist may prescind from the question of objective correlatives and limit himself to operational definitions, mathematical deduction, and verification by experiment. Hence the popularity of the non-committal name, "constructs."

Two of the basic norms by which a physical theory is judged are consistency and verification. Consistency implies not only a self-consistent system but also that a new physical theory be consistent with the established theories, at least in the region in which the older theories have proven their validity. This is an extension of the "Bohr Correspondence Principle" by which quantum mechanics merges with classical mechanics for large quantum numbers. Verification, as has been seen briefly, really means consistency with reality as it is apprehended through measurement and experimentation.

Author and Title Index

Volume 31.

1953 - 1954

LEGEND.

- ABS abstract of paper
AUTH author
BRev book review
OBIT obituary

- ABSORPTION. in water: Hall Theory. Ultrasonic, ABS 27; of ultrasonic energy in liquids by the pulse method. ABS 26
- Acclimatization studies. Cold, ABS 10
- Aliphatic amines in the presence of Raney nickel catalyst. Disproportionation of primary (dissertation abstract), 70
- ANALYSIS. Formula for indirect gravimetric, ABS 13; see also calibration.
- Annual meeting. See this ASSOCIATION, Michigan.
- Approximate numbers. Computations with, ABS 20
- Artificial hibernation. ABS 11
- ASSOCIATION (this). 28th annual meeting, St. Joseph's College, Phila., Pa., 1953: program, 4; sec'y report, 6; membership list, 1953-1954, 120
- Astronomy. Some Jesuit contributions to, 62
- Astrophysics symposium at the University of Michigan. ABS 28
- Atom and the cross. 8
- Awards for 1954-1955. National Science Foundation pre-doctoral, 109
- Bagdad College. Chemistry teaching at, ABS 15
- Bauer. Mark H., AUTH 11
- Bezuszka. Stanley J., AUTH 27
- Binary mixtures. Indirect gravimetric analysis. ABS 13
- Biologist in the making. ABS 11
- Brennan. Robert O., AUTH 28
- Calibration of a large volumetric flask. ABS 16
- Canavan. Frederick L., AUTH 28
- Carbon cycle in nature. ABS 17
- Catalysis research. Recent trends in, ABS 14
- Catalyst. The disproportionation of primary aliphatic amines in the presence of Raney nickel, ABS 70
- CELL(ular) GROWTH. The effects of thyroxin on nucleic acids during, 101, ABS 16; on nucleic acid. Dependence of, 94
- CHEMISTRY. teaching at Bagdad College. ABS 15; workshop conducted at Penn. State College. Report on the, ABS 15
- Clark. Joseph T., AUTH 24, 40
- Cold acclimatization studies. ABS 10
- Commentary on evolution. 76
- Computation with approximate numbers. ABS 20
- Congruences. ABS 20
- Cosmology. Toward an effective 20th century, ABS 24
- Cross. The atom and the, 8
- Delaney. John P., AUTH 8
- Dipole moments of substances. Methods of determining the, ABS 15
- Education in science*, by I. B. Cohan and F. G. Watson. *General*, BREV 71
- Elements. The rare earth, ABS 12
- Evolution. A commentary on, 76
- Fahey. Richard D., AUTH 29
- Fiekers. Bernard A., AUTH 13, 112, 118
- Formula for indirect gravimetric analysis (binary mixtures). ABS 13
- Green. John W., AUTH 20
- Growth. See cellular.
- Hall theory. Ultrasonic absorption in water; ABS 27
- Harry. Alwyn, AUTH 76
- Heyden. Francis J., AUTH 21
- Hibernation. Artificial, ABS 11
- Hilsdorf. George J., AUTH 14
- HISTORY. Jesuit contributions to astronomy. 62; *of science*, by George Sarton. BREV 116; Wasmann collection. 112

- Holy Cross. Department of Chemistry. News Items. College of the, 118
- Hufnagel. Alvin A., AUTH 12
- Hutchinson. Gerald F., AUTH 15
- Indirect gravimetric analysis. Formula for, ABS 13
- JESUIT(s). contributions to astronomy. Some, 62; Some research projects for, 21; Science Colloquium at Weston College, a progress report. 29
- Lawlor. George F., AUTH 10
- Lewis. Charles J., AUTH 20
- Light-integrator for the spectrograph, ABS 14
- Liquids by the pulse method. Absorption of ultrasonic energy in, ABS 26
- MacDonnell. John J., AUTH 19, 104
- Mappings. Simple examples of topographical, ABS 20
- Martus. Joseph A., AUTH 14, 70
- McCarthy. Martin F., AUTH 29
- McCarthy. Paul J., AUTH 15
- McGuinn. Albert F., AUTH 16
- McKeough. James A., AUTH 12, 87
- Mechanism of photosynthesis. 87, ABS 12
- Meeting. See this ASSOCIATION.
- Membership of this ASSOCIATION 1953-1954. 120
- Mercury—198. Spectrum of, ABS 28
- Michigan. Astrophysics symposium at the University of, ABS 28
- Mixtures. Formula for indirect gravimetric analysis of, ABS 13
- Mulligan. Joseph F., AUTH 28, 109
- National Science Foundation, pre-doctoral awards for 1954-1955. 109
- Naught but a number. Zero is neither nothing nor, 40
- Nickel catalyst. The disproportionation of primary aliphatic amines in the presence of Raney, ABS 70
- NUCLEIC ACID(s). The dependence of cell growth on, 94; during cell growth. The effects of thyroxin on, 101; ABS 16
- Numbers. Computation with approximate. ABS 20; See also naught.
- O'Connor. John S., AUTH 27
- Odyssey of the Wasmann collection. 112
- Pennsylvania State College. Report on the chemistry workshop conducted at, ABS 15
- Periodic Table. Various forms of the, ABS 14
- Persich. Joseph A., AUTH 20
- Philosophy and science. A commentary on evolution. 76; Towards an effective 20th Century cosmology. ABS 24
- Photosynthesis. Mechanism of, 87, ABS 12
- Program of the 28th annual meeting. THIS ASSOCIATION. 4
- Pulse method. Absorption of ultrasonic energy in liquids by the, ABS 26
- QUANTITATIVE ANALYSIS. Calibration of a large volumetric flask. ABS 16; Formula for indirect gravimetric analysis. ABS 13
- Quantum mechanics. A "new" interpretation of, ABS 28
- Raney nickel catalyst. The disproportionation of primary aliphatic amines in the presence of (dissertation abstract), 70
- Rare earth elements. ABS 12
- Research projects for Jesuits. Some, 21
- Rotating string. Modes of vibration of a, ABS 27
- Ruddick. James J., AUTH 26, 109
- Ryan. Joseph L., AUTH 15
- Saint Joseph's College, Phila., Pa., 1953, 28th annual meeting of THIS ASSOCIATION. 4
- Schubert. Clarence C., AUTH 14
- SCIENCE. Foundation pre-doctoral awards for 1954-1955. National, 109; General education in, BRev 71; see also philosophy; Colloquium at Weston College, a progress report, 29
- Scully. Bernard, AUTH 17, 71, 116
- Secretary's report of the 28th annual meeting of THIS ASSOCIATION. 6
- Series. An introduction to the Fourier, ABS 18
- Spectrograph. Light-integrator for the, ABS 14
- Spectrum of mercury—198. ABS 28
- Thyroxin on nucleic acids during cell growth. The effects of, 101, ABS 16

- Tobin. John A., AUTH 26
- Topographical mappings. Simple examples of, ABS 20
- Topology. Development and scope of, 104, ABS 19
- Transistors. Their operation and application. ABS 26
- ULTRASONIC. absorption in water. Hall theory. ABS 27; energy in liquids by the pulse method. Absorption of, ABS 26
- Varela. Miguel A., AUTH 16, 94, 101
- Vibration of a rotating string. Modes of, ABS 27
- Volumetric flask. Calibration of a large, ABS 16
- Walsh. Michael P., AUTH 11
- Wasmann collection. Odyssey of the, 112
- Water. Hall theory. Ultrasonic absorption in, ABS 27
- Weston College. Progress report of the Jesuit Science Colloquium at, 29
- Workshop conducted at Pennsylvania State College. Report on the chemistry, ABS 15
- Zero is neither nothing nor naught but a number. 40