A. M. D. G.

BULLETIN

of the

American Association of Jesuit Scientists

Eastern States Division

(Founded 1922)

PROCEEDINGS

OF THE

TWENTY-THIRD ANNUAL MEETING

August 31, September 1 and 2, 1948

College of the Holy Cross, Worcester, Mass.

Vol. XXVI SEPTEMBER, 1948 No. 1

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Bulletin of the American Association of Jesuit Scientists

EASTERN STATES DIVISION

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Twenty-third Annual Meeting

OF THE

AMERICAN ASSOCIATION OF JESUIT SCIENTISTS

EASTERN STATES DIVISION

College of the Holy Cross

August 31, September 1 and 2, 1948

GENERAL MEETINGS

Tuesday, August 31, 1948 at 7:45 P.M., in Alumni Hall

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READING OF THE MINUTES—Mr. Edward J. Kilmartin, S.J., Acting Secretary

APPOINTMENT OF COMMITTEES

REPORT OF COMMITTEES

NEW BUSINESS

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"Rev. Theodor Wulf, S.J., 1868-1946, A Jesuit Physicist"

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The Background for Studies in Biology—Rev. Michael P. Walsh, S.J., Symposium Director

Discussion—Rev. Michael P. Walsh, S.J.; Mr. George L. Drury, S.J.; Mr. William H. Janer, S.J.

The Evolution of the Embryo—Mr. John V. Owens, S.J.

The Rh Factor, Its Discovery and Recent History—Mr. William K. Masterson, S.J.

The Philosophy of Biology—Mr. Francis J. MacEntee, S.J.

BUSINESS MEETING OF THE SECTION

Chemistry Section

CHAIRMAN'S ADDRESS. Physical Chemistry, the Armchair Pilot Plant—Rev. James J. Pallace, S.J.

Illustration of Kinetics by Shadow Projection—Rev. Bernard A. Fiekers, S.J.

Problems in E.M.F. Cells—Rev. Joseph A. Martus, S.J.

Lecture Experiments in High School Chemistry—Mr. Alfred B. Orth, S.J.

The High School Chemistry Syllabus—Mr. Thomas F. Egan, S.J.

Laboratory Safety through Home Made Movies—Mr. Frederick J. Dillemuth, S.J.

Diagnostic Principles in Organic Chemistry—Mr. Edward J. Kilmartin, S.J.

Chemical Applications of Ultrasonics—Mr. Charles F. Turner, S.J.

BUSINESS MEETING OF THE SECTION

Mathematics Section

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Algebra—Mr. William J. Egan, S.J.

Analysis—Rev. George A. O'Donnell, S.J.

Analytic Geometry—Rev. Gerard J. Costello, S.J.

Differential Equations—Rev. Edward B. Berry, S.J.

Geometry—Rev. William H. Schweder, S.J.; Rev. Timothy P. Reardon, S.J.

Trigonometry—Mr. John W. Green, S.J.

Vector Analysis—Rev. Frederick W. Sohon, S.J.

What Are Sines Sines of?—Rev. Arthur Steele, S.J.

Evolution of a Determinant—Mr. Richard J. Roszel, S.J.

A Method of Teaching Word Problems in Algebra—Mr. William J. Egan, S.J.

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Results of a Physics Questionnaire—Rev. Robert B. MacDonnell, S.J.

Discussion—Rev. Henry M. Brock, S.J.; Rev. John S. O'Connor, S.J.; Rev. John A. Tobin, S.J.

Some A.C. Laboratory Problems—Rev. James W. Ring, S.J.

Radioactive Tracers—Rev. John A. Tobin, S.J.

Pulse Techniques in Ultrasonics—Mr. Joseph F. Mulligan, S.J.

A New Method for the Determination of Centripetal Force—Mr. Frederick L. Canavan, S.J.

The Ratio of Specific Heats of Methane by Ultrasonic Measurement—Mr. Robert O. Brennan, S.J.

A New Tensor Force Model for the Deuteron—Mr. William G. Guindon, S.J.

Measurement of Temperature in the Vicinity of the Absolute Zero—Mr. John F. Devane, S.J.

BUSINESS MEETING OF THE SECTION

SCIENCE AND PHILOSOPHY. An Epistemological Interpretation of the Uncertainty Principle—Rev. Joseph P. Kelly, S.J.

Secretary's Report

The twenty-third annual meeting of the American Association of Jesuit Scientists, Eastern Division, was held at the College of the Holy Cross on August 31, September 1 and 2, 1948.

FIRST GENERAL SESSION

In the absence of Reverend Father Rector, Father James E. Fitzgerald, Dean of Studies at Holy Cross College, gave the Address of Welcome.

The reading of the minutes of the last meeting was dispensed with, since the secretary's report was approved as printed in the September 1947 issue of the Bulletin.

The President of the Association appointed Mr. Edward J. Kilmartin to act as secretary in the absence of Mr. Charles G. Crowley. Robert O. Brennan, Frederick L. Canavan, Joseph F. Mulligan and Father Bernard A. Fiekers were appointed as members of the Index Committee. The Nominating Committee was composed of Fathers Vincent A. Gookin, Edward S. Hauber and Frederick W. Sohon. Father Joseph M. Kelley and Father James L. Harley were appointed to the Resolution Committee. The Program Committee was under the supervision of Father Thomas J. Smith, Chairman; while Father James K. Connolly directed the activities of the Reception Committee.

The report of the Executive Committee was read by the President. It included an announcement concerning the possible publication of a twenty-five volume index to the Bulletin. All those who were attending the meeting for the first time were accepted as members. Last of all, the President made an announcement concerning the formation of a Constitutional Revision Committee.

The Presidential Address, entitled, "Reverend Theodor Wulf, S.J., 1868-1946, A Jesuit Physicist", concluded the meeting.

On Wednesday morning and afternoon the meetings of the various sections were conducted. After dinner Father Francis J. Heyden showed motion pictures of National Geographic's Brazilian Eclipse

Expedition. Father Francis J. Heyden and Father Lawrence P. McHugh appeared throughout the picture.

BUSINESS MEETING

The final general session was held Thursday morning at 10.00 in the Physics Lecture Hall.

Father John A. Frisch was elected President of the Association and Father Henry A. Boyle was elected Secretary.

Father J. P. Kelly asked that back issues of the Bulletin be sent to Weston if there are extra copies in the various houses.

The secretaries of the various sections reported the results of the elections as follows:

BIOLOGY	*Chairman*—Rev. Joseph F. Busam
	Secretary—Mr. William Masterson
CHEMISTRY	*Chairman*—Rev. James J. Pallace
	Secretary—Mr. Frederick J. Dillemuth
MATHEMATICS	*Chairman*—Rev. William H. Schweder
	Secretary—Mr. George T. Zorn
PHYSICS	*Chairman*—Rev. Joseph F. Cohalan
	Secretary—Mr. Frederick L. Canavan

Father J. M. Kelley read the following Resolutions which were accepted by the General Assembly.

1. Be it resolved that the American Association of Jesuit Scientists (Eastern Division) express to Reverend Father Rector, William J. Healy and Father Minister, Francis Toolin and to the Community of Holy Cross College its sincere appreciation of their warm welcome and generous hospitality during our stay.

2. Be it resolved that the Association express its gratitude to the members of the reception committee and in particular to the chairman.

3. Be it resolved that the Editor of the Bulletin be commended for his untiring labor in the editing and publishing of the Bulletin.

4. Be it resolved that the Association offer congratulations and best wishes to Fr. Edward C. Phillips, former president, and to Fr. Joseph S. Didusch and Fr. Joseph J. Daley on the occasion of their Golden Jubilee in the Society.

5. Be it resolved that the secretary of the Association be instructed to transmit a copy of these resolutions to the above mentioned Fathers.

Signed: Rev. Joseph M. Kelley, S.J.
Rev. James L. Harley, S.J.

At the conclusion of the meeting Mr. Charles A. Turner demonstrated the Chemical effects of ultrasonics. After the demonstration Father Francis J. Heyden brought the meeting to a close with more pictures of the Brazilian eclipse.

Respectfully submitted,

Edward J. Kilmartin, S.J.
Acting Secretary

Presidential Address

REV. THEODOR WULF, S.J., 1868-1946, A JESUIT PHYSICIST

Rev. Bernard A. Fiekers, S.J.

In my endeavor to select a topic that would be of interest to all of you, Reverend Fathers and dear Brothers in Christ, I finally chose one that was very near to me in the memory and record of the late Father Theodor Wulf of the Society of Jesus, a modern Catholic scientist and physicist, teacher, author, philosopher, priest, administrator and Jesuit. Many of you knew him personally before I became acquainted with him on the eve of World War II as my Father Minister in Valkenburg, as Father Socius and as Father Provincial. If I can introduce this lovable character to you or but add to your own knowledge and esteem of him, then I should be happy indeed to discharge in this way my obligation to address you.

Theodor Wulf was born on June 26, 1868 in Hamm in Westphalia. On graduating from Gymnasium twenty years later he joined the Society of Jesus then in exile from the "Reich" in Exaten, the Netherlands. From the year 1890 until 1893 he studied philosophy in Exaten and during his last year taught Greek there to the younger scholastics. During regency he instructed in Feldkirch for one year, and then studied mathematics and physics for three years at Innsbruck. In 1897 he passed the "Staatsexamen" in this course. In September of the same year he appeared as a first year theologian in Valkenburg, Limburg, the Netherlands. He was ordained to the holy Priesthood there in 1900. A fourth year of theology followed. From 1901 to 1903 he studied physics under Nernst at Goettingen and then concluded his Jesuit training with a year of tertianship in Wijnantsrade, a small village near the Valkenburg theologate.

In the autumn of 1904 he became Professor of Physics in Valkenburg. In 1926 he took on the added task of Professor of Inorganic Cosmology. Wulf kept these positions until 1935 when the philosophate was being transferred to Pullach near Munich in Germany. He then remained in Valkenburg one year longer in the capacity of "House Minister". In 1936 he became Socius to the Provincial in Cologne; in 1938 Provincial for Lower Germany, a post which he relinquished in 1942 to become Hospital Chaplain in Hallenberg, Westphalia. At last, worn out with all his duties, and with severe suffering at the end, Fr. Theodor Wulf, S.J., answered the call of his Creator on June 14, 1946 in Hallenberg.

Father Wulf was an outstanding Jesuit. He inherited a genuine Loyola spirit directly through his most renowned Master of Novices,

Fr. Moritz Meschler, S.J. So much of his life shows such marked solicitude for the things of the Institute that it would be a shame to allow significant instances in point to pass unmentioned.

Apart from Father Wulf's scientific career, with which we have mainly to deal, one cannot pass over his contributions to the Cosmological Convention in Rome in the middle of the twenties. Further, Fr. Socius Wulf's plea to the twenty-eighth General Congregation for a scientific reply to modern errors[63] came to our attention in our own BULLETIN.[a] This was made jointly with Father del Pulgar and developed into a plan for a Cosmological Institute similar to the Biblical Institute in Rome. But the exigencies of war and the untimely death of Fr. del Pulgar stifled the infant project.

Actually to live the rule of begging "ostiatim" when necessary; to administer a house without visible financial support; and to administer a whole province in time of war and vicious persecution, indicate that the Jesuit had good administrative ability. For, a German house in the Netherlands must needs be supported from Germany, especially when it had been heavily mortgaged in order to build a college within the borders of the Reich. On the other hand Germany limited, or completely forbade, the transfer of money beyond her reach, even funds for paying the mortgage off. To pack the house with "degentes" supported by other provinces did not solve the problem either. To dig, the Jesuit was not unable, nor was he ashamed to beg. Week by week the begging was organized by announcements on Sunday in the villages of southern Holland, and during the week many scholastics and Fathers begged from door to door. Arrangements were made for trucking tons of potatoes at harvest time, for example. Father Minister was very active in all of this work and sometimes led the attack. Thus he became Father in the new sense of provider.[b, c]

Sometimes a father must stand at the gate to protect his children. It is not difficult to imagine him as Provincial before the Gestapo investigators, though we cannot prove it from records available today. Under the title of Herr Professor, however, he maintained correspondence with Fr. Albert Maring[d] (+iv.8.43) in the concentration camp, Dachau, and supplied his imprisoned sons with packages of so-called delicacies from time to time like the old Father Minister of a bygone year.

A report[e] made in 1946 by the succeeding Provincial gives us an

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[63]Arabic numerals refer to the number of the item in "a substantial bibliography" of Father Theo. Wulf's publications, THIS BULLETIN, *19*, 92-95 (1941). Other references will be lettered: a, b, c, etc.

[a]THIS BULLETIN, *16*, 98 (1939).

[b]Kingdon, S.J., Rev. Jas. B., Letters & Notices, *51*, 207 (1936).

[c]Wulf, S.J., Rev. Theo., Letter to Rev. C. P. Gisler, S.J. Monatsbote (Holy Trinity Church, Boston, Mass.) (1936).

[d]Mitteilungen aus den deutschen Ordensprovinzen der G. J., no. 110, pp. 57-8 (1946).

[e]Flosdorf, S.J., Rev. Wilh., Die deutschen Jesuiten unter den nationalsozialisten Regime, ibid., no. 110, p. 3, 1946.

insight into the difficulties that confronted Fr. Wulf in office. After the Nazi victory in the West, they turned to deal the final blow to the Church in Germany. In this one province, eight Jesuit residences, the novitiate, the collegium maximum and the college at Godesberg on the Rhine were practically lost to the Society by 1942. Thus one hundred and seventy-eight Jesuits were thrown into the streets on unreasonably short notice. Eighty-eight of these were banished into non-Catholic territory in order to cripple their apostolate. And all the while there were four hundred Jesuits at the front, nor were they necessarily there as chaplains.

The complaint of injustice to the servicemen who had lost their homes in this fashion was answered with an order from the Fuehrer to discharge them dishonorably as unworthy of bearing arms for the Reich. Naturally many of the four hundred then escaped detection; and many too were called upon for the supreme sacrifice.

So much then for the distinctly Jesuit and administrative details in Fr. Wulf's record. His stature as a modern physicist is beyond dispute. It has been observed that new fields in physical science began to flourish once the proper instrument for their exploration has been invented and perfected. Astronomy and the telescope, biology and the microscope, chemistry and the balance seem to justify the observation. With Father Wulf, it is the application of his electroscope to the fields of atmospheric and static electricity, cosmic rays and radioactivity. The physics teacher and author in Wulf then follow from this foundation. Wulf the philosopher and Wulf the chemist are probably incidental.

Father Wulf's great contribution was the quartz fibre electrometer. Other instruments of the sort had been developed for qualitative and semi-quantitative work. In a series of about 15 papers (items 7, 8, 9, 10, 13, 18, 19, 20, 25, 31, 39, 42, 43, 47, 51, 52, 55, 56, 61) and some books from 1906 to 1935 an electrometer named after its inventor has been described in all its various forms and applications. These publications are to be found largely in the pages of the *Physikalische Zeitschrift*. The application of these instruments to atmospheric and static electricity, along with radioactivity has made them standard equipment in physical laboratories the world over both in education and in industry. Only in the field of radioactivity has the electrometer been made obsolete by the Geiger counter, an instrument on which Wulf also published (item 45).

The availability and development of the electrometer over the years opened a modern attack on atmospheric electricity. This led to the discovery of cosmic rays and to very fertile research in radioactivity which at the time of World War I was in a stage of great development.

To Wulf we owe another series of papers (items 11, 12, 15, 17, 21, 23, 24, 25, 30) that also appears largely in the *Physikalische Zeitschrift* over the years 1908 to 1913, in which very penetrating rays in the

atmosphere and their origin is discussed. In substance: it was found that electrometers seemed to be discharging spontaneously. The phenomenon had probably been recognized quite generally with the earlier instruments, but serious quantitative study had been practically impossible. But now measurement under various conditions could be made. The college garden, the roof, the caves in Valkenburg, the high Alps and even the Eiffel Tower in Paris supplied a variety of conditions for studying the anomaly. The theory of atmospheric electricity merged into a theory of penetrating rays from the outer atmosphere.

A particularly disturbing element in this study was the presence of very slightly radioactive materials wherever the experiments were performed. Potassium is known to be naturally radioactive, and even the top of the Eiffel could not supply certain refuge from such a gremlin. This marks the beginning of Wulf's study of radioactivity itself. Indeed, we find earlier papers from his pen (items 26, 27, 28) that postulate radioactivity as a general property of matter.

Meanwhile other investigators were beginning to fill the field, including the American, Robert A. Millikan. It remained for the Austrian, Victor Hess, to clinch the phenomenon of cosmic rays with indisputable quantitative evidence, by making a balloon ascent with the Wulf instruments, thus eliminating radioactive interference from the earth below and showing the increase in cosmic ray effect as the ascent progressed. On the eve of World War I the following European workers in the field of cosmic rays met in Vienna: Benndorf, Dorno, Hess, von Schweider and Wulf. Their report is printed in the *Physikalische Zeitschrift* for 1913 (item 30). It is the last report on cosmic rays to bear Wulf's signature.

The Jesuit was then preoccupied with his instrument, especially in connection with radioactivity (items 25, 26, 27, 28, 50, 48, 62). Indeed, his bifilar electrometer was recognized as early as 1910 by the Radium Congress in Brussels.[f] Much of our data for Wulf the physicist stems from the pre-World War I era. During that war he served as a division chaplain in the field. His wireless at Valkenburg was sealed up by the Dutch Government at the time and, as hearsay has it, his laboratory was neutralized by an armed guard. He returned from war in 1919 and published with Nernst a note on correcting Planck's radiation formula.

Between the two world wars his stature as a physicist is best described under the formality of teacher of physics in its broadest sense. The Jesuit physicist's vocational interest in philosophy might possibly explain his two books on Einstein's theory of relativity (items 35, 36).

Wulf was a superb designer of apparatus as well. He had a knack in design to balance out variables to almost any desired degree. In making ever novel models of his instructional and research apparatus

[f]Nachrichtungen fuer Auswaertigen, Portrait Supplement, April 1936.

he was ably assisted by Brother Rodemund, S.J., in catalogus Latin described as "mechan." The electrometer was adapted to rugged projection and student use. A trolley (item 58) for showing the laws of motion was constructed so that variables could be studied one by one. During this period contributions begin to appear more frequently in the journals of science education. A master of practical vibrational analysis on which he later wrote a monograph (item 60) he designed a swinging mirror for demonstrating quantitatively the delicate gravitational attraction between objects on the earth's surface. With it, he and some of his students could get quantitative results (items 38, 59). Mis model for illustrating the kinetic theory with ball bearings (item 34) also quantitatively, provided another laboratory exercise for his second philosophers. Add to these the Wilson apparatus to "video" alpha particles (items 41, 50); his work on electrical condensers (items 14, 20, 44); the Geiger counter modified for a school experiment in the twenties (items 45, 48)—and you have some idea of the fruitful work of the man. Leybold in Cologne and Berlin manufactured most of these devices, once they were perfected.

This rich background in the teaching of physics to "ours" found expression in his book *Modern Physics*. Undoubtedly it had gone through some multigraphed trial editions at Valkenburg. Profound changes had occurred in physics since the days of his teacher and predecessor, Fr. Louis Dressel, S.J., whose elementary treatise on physics had finally gone out of print after many editions. A completely new book was called for, to emphasize the structure of matter, rather than the conservation of energy, as Dressel had done.

Most readers agree, I think, that Fr. Wulf plumbed in stimulating fashion the very depths of many topics in his book on modern physics. It is accordingly no great criticism to state that the book was hardly suited to students of "first physics"; that it might or might not be suited to our physics courses in the Society, since objectives vary with place and time; but that it is eminently suited to teachers of science and others who are somewhat familiar with physics, precisely because the author comes to grips with fundamentals in an amazingly simple way. The book has been published in one English and two German editions (items 53, 54); a Spanish edition was contemplated before the war.

It was probably the philosopher in Wulf that prompted him to write his "Bausteine", Building Stones of the Material Universe (item 62). We find too, theses in his cosmology manuscript that state (item no. 57):

"Mutationes substantiales in inorganicis probari nequeunt, speciatim atomi in compositionibus chimicis manent."

"Corpora constituuntur atomis; atomi constituuntur nucleis cum electronibus."

One might look on the "Bausteine" as an elaboration of the minor

premise in the second thesis cited. During the second World War Fr. Wulf was working on a second edition of the "Bausteine". Shortage of paper prevented its publication. By hearsay we know that he recognized a mine of energy in subatomic particles and was confident of its eventual release. Indeed the reaction of many of his students to scientific progress seemed invariably to find expression in the attitude: Father Wulf told us that years ago.

In the classroom Father Wulf proved to be a born teacher. Undoubtedly he concealed in a very clever way the sweat and blood that went into the preparation of material that was always aimed at simplicity and clarity. A bit of a positivist by avocation, he was ever ready to profit and improve the technical aspects of his teaching from tradition, experience, experiment, observation and reflection. By nature he had the bent of an imitator and actor. He divided his interests happily between people and things, and was often remembered for acting in agony over some philosophical adversary who had misused the formulations and findings of physics to bolster an argument. At times too he added chemistry to his teaching repertoire. Scientists with a chemical bias could look upon him as a physical chemist as well; for one cannot forget the Nernst influence. The "Leitfaden" (item 29) or Outlines of General Chemistry, was printed as a manuscript in 1912. With but minor modifications it would do credit to any of our colleges today.

For the information in this paper I am indebted to various publications of "ours" in the Province of Lower Germany, especially to the *Nachrichten* and *Aus den Provinz(en)*. The bibliography which appeared in the BULLETIN in 1941 has provided most of its substance. This bibliography had been compiled initially from reprint collections in the libraries of Ignatius College in Valkenburg, and completed substantially by consultation of Chemical, and Physics Abstracts. For more personal data on Father Wulf I am especially indebted to Rev. Nicholas Junk, S.J., Rector of St. George's Seminary, Frankfurt, Germany, who graciously afforded a preview of an obituary of Wulf to be published eventually in the literature of physics. His cover letter gave many added details. Father Koch's "Jesuitenlexikon" was also of value.

We have glanced back and can now look forward. Additional information on Wulf seems to be desirable. I think that a careful study of his life would be most valuable for any of us in science. For there we find the solution of many difficulties that are peculiarly "ours".

Biology

THE "NEW" BIOLOGY

(abstract)

Rev. Anthony J. MacCormack, S.J.

A modern tendency in biology was briefly considered. It is an ever narrowing focus in which biology becomes only the chemical, physical and mathematical measurement of organized states of matter. Yet simultaneously such data is interpreted to explain all the human activities of man. The chief applications are in the social sciences of anthropology, psychology and sociology.

SYMPOSIUM ON GRADUATE STUDIES IN BIOLOGY

(abstract)

George L. Drury, S.J.

A program of studies for scholastics in biology was discussed in detail by Fr. Walsh. The need for beginning scientific preparation at an early date in chemistry, mathematics and physics was emphasized. The opinion was also expressed that in the three years period of philosophy, together with the intervening summers, more science courses could be covered than at present, giving a much better background in allied sciences for degree work later during regency. A detailed curriculum for biologists during the three years of philosophy was presented for consideration.

Five different plans covering the period of regency were next presented in detail. Based on a three year regency, these were designed in view of the many possible appointments for a biologist during regency. One of these plans, obtaining an M.S. degree in chemistry, was discussed by Mr. Drury. The advantages to a biologist of this intensive training in chemistry were considered. Another of these regency plans was presented by Mr. Janer. His curriculum at Spring Hill College, leading to a B.S. degree, and his subsequent work in regency as a student and teacher were discussed.

It was agreed that the program as outlined by Fr. Walsh should be sent to each member of the section for personal comments and criticisms. From these reports a final program will be adopted.

THE EVOLUTION OF THE EMBRYO
(abstract)

JOHN V. OWENS, S.J.

This paper attempts to prove that the rational soul is created, not at the first moment of fertilization, but at some subsequent time, by a consideration of the development of the human embryo. According to this opinion, the first type of life that the embryo has is vegetative, then the sensitive soul is educed, and finally the rational soul is created. This better explains the phenomenon of monozygous twins, whose souls are created only after the zygote has split.

THE Rh FACTOR
ITS DISCOVERY AND RECENT HISTORY
(abstract)

WILLIAM K. MASTERSON, S.J.

The Rh factor is so named because it is a blood antigen found originally in the corpuscles of the Rhesus monkey, *Macaca Mulatta*. It was discovered in 1937 by Doctors Karl Landsteiner and Alexander Wiener. However, the first paper dealing with its occurrence in human blood did not appear until June 1940.

Dr. Wiener and his associates worked with rabbit antibodies in an attempt to determine the specificity of the anti-Rh agglutinins. Dr. Philip Levine and his group focused their attention on the causes of hemolytic reactions in obstetrical cases.

In general, there have been three types of remedies applied as solutions to the Rh problem. 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, etc.; (3) To fight nature with her own weapons by finding something to neutralize the antibody produced. This last remedy is the only real solution to Rh-isoimmunization. This remedy is at present under active investigation.

THE PHILOSOPHY OF BIOLOGY
(abstract)

FRANK J. MACENTEE, S.J.

For the scholastic philosopher of the past, the term science meant knowledge in the strict sense of the word; even philosophy was catalogued as one of the sciences. This classification could not long stand, however, for the sciences, groping for causal explanations, could go no deeper than the surface; while philosophy, shaking the clods of ignorance and doubt from the very roots of the problem, came up with the most perfect knowledge attainable—from ultimate causes. Since, then, the sciences and philosophy are separate due to their formal objects, there must be a philosophy of each science to explain primary causes which the science alone cannot do.

The material object of biology is organic life in general; its formal object is observation and experiment. This immediately limits the biologist to surface work. Therefore the philosopher should not take it amiss when there is no mention of a soul, for the biologist sees no soul under his microscope. In fact, if, as a biologist, he did make any attempt to explain animation, he would be entering a domain not his own. It is only when he leaves his own field and, as a philosopher of life, applies higher principles of reason to what he experienced as a biologist, that he may apply any soul-theory.

There have arisen two extreme schools concerning the philosophy of biology: mechanism that denied anything superior to science, and vitalism which, as biology, taught the existence of the entelechy, denying that philosophy alone could reach the soul. Biology alone can no more discover the soul than the doctor see the amount of intelligence in the brain beneath his scalpel. The biologist knows there is a soul only when he ceases to be a biologist and becomes a philosopher.

Since science and philosophy have so much to gain from each other, they should function harmoniously. The biologist should not refuse to submit his data to the searchlight of metaphysical principles, for the more perfect the data, the more perfect will be philosophy's search for their causes; nor should the philosopher consider it beneath him to keep posted on modern scientific discoveries. The knowledge resulting from this felicitous combination would be not only the clearest possible knowledge but would lead unerringly to Knowledge Itself, the living font of all wisdom.

Chemistry

PHYSICAL CHEMISTRY, THE ARMCHAIR PILOT PLANT
(abstract)

Rev. James J. Pallace, S.J.

Vast expenditures of money, equipment, and time can be saved by applying the principles of physical chemistry in determining the practicability of a chemical reaction. Using experimental values for the heat of formation of each substance the heat of reaction of the entire process can be determined. In a similar way entropy values can be calculated on paper. From these values the free energy of the reaction and, consequently, the equilibrium constant can be arrived at. In some cases, from the heat of reaction, we can deduce the effect of temperature on the speed of reaction. Moreover, if it should be an electrode reaction, the E.M.F. can be calculated from the free energy of reaction.

ILLUSTRATION OF KINETICS BY SHADOW PROJECTION

(abstract)

Rev. Bernard A. Fiekers, S.J.

This convention was used as an occasion to exhibit the apparatus developed at Holy Cross by B. A. Fiekers, S.J. and G. S. Gibson, S.J., a description of which was published in the Journal of Chemical Education, *22*, 305-308 (1945). All of the illustrations were given except the one for osmotic pressure. Besides, the suggestion was made that a large frame, vibrated by hand on the lecture desk with a number of large "glassies" or ball bearings within its enclosure, might make a good substitute for such apparatus in everyday instructional use.

PROBLEMS IN E.M.F. CELLS

(abstract)

Rev. Joseph A. Martus, S.J.

The following problem was discussed and an inquiry made for a satisfactory reason: When two half-cell reactions are added or subtracted to give a complete reaction, the standard E.M.F.'s of the two half-cells are added or subtracted to give the standard E.M.F. of the complete cell. However, when two half-cells are added or subtracted to give a third half-cell, the standard E.M.F. of this third half-cell must be calculated through the standard free energy changes of the two initial half-cells. A completely clear, convincing conclusion was not arrived at in the public discussion.

LECTURE EXPERIMENTS IN HIGH SCHOOL CHEMISTRY

(abstract)

Alfred R. Orth, S.J.

Lecture experiments arouse the interest of high school boys in chemistry. They teach him laboratory technique, co-ordinate lecture and laboratory work and enable the student to witness reactions which would be too intricate or too dangerous for him to perform by himself. Such experiments should be well-planned, well-timed and well-executed, with as much student participation as possible.

Supplementary experiments in laboratory manuals and in the text itself furnish a rich supply of classroom experiments. They entertain and do teach matter that is not easily forgotten when impressed on the memory in this way.

DIAGNOSTIC PRINCIPLES IN ORGANIC SYNTHESIS

(abstract)

EDWARD J. KILMARTIN, S.J.

Most chemistry teachers and their students are familiar with problems in the textbooks that deal with the synthesis of a more complex, probably highly branched organic compounds, from the very inorganic elements themselves or from simple, readily available organic compounds. The main difficulty encountered in these problems is to build up the carbon skeleton. A systematic approach is here proposed. But it is generally limited to aliphatic, acyclic, monofunctional structures.

First, if the carbon chain is interrupted by the elements, O, N, S, or the like, then the synthesis of ethers, acetals, esters from appropriate, simpler reagents is demanded. The problem then devolves into the synthesis of these. Secondly, if a symmetrical structure, which has an even number of carbon atoms, is desired, a Wurtz reaction is indicated; or probably a sodium malonate, a sodium acetoacetic ester (so-called inverted Wurtz reaction) or possibly a Grignard or Reformatsky synthesis. Thirdly, if the desired structure is symmetrical with an odd number of carbon atoms, the synthesis of a symmetrical ketone from appropriate organic acid structures might be indicated. Fourthly, if single branching is desired in the compound, the Grignard reaction might be investigated. Fifthly, the action of an appropriate Grignard reagent on a ketone to form a tertiary alcohol might be used where double branching off the same carbon atom is required. More complicated cases can be shown and one does not always have to fall back on the Grignard synthesis. Undesirable functional groups may be substituted or "erased" so as to give the hydrocarbon structure. The system has pedagogical value as an exercise, and in putting emphasis on the carbon skeleton; research value, in highlighting gaps in the literature; and it has a philosophical value, in estimating the task that would be involved in the chemical synthesis of the "vitally organized state of matter".

CHEMICAL APPLICATIONS OF ULTRASONICS

(abstract)

CHARLES F. TURNER, S.J.

In connection with some research work being done by the author at Holy Cross under the direction of Prof. A. VanHook, a paper was given in the chemistry section of the Association in order to cite some recent instances in the application of ultrasonics that have come to general attention through the press; in order to indicate the beginnings of work done here; in order to explain the apparatus and demonstrate it to other members of the Association outside of the chemistry division as well.

The apparatus makes use of the magnetostriction method. This is driven by an audio oscillator, a 500 watt amplifier and associated power supplies. At present exploratory experiments with difficulty crystallizable substances are being conducted at the audible-inaudible threshold. An extension into the inaudible range is planned.

The demonstration was confined to the defoaming of a carbonated beverage, the exhibition of a water mercury system which was emulsified by this method and the emulsification of machine oil in water.

THE HIGH SCHOOL CHEMISTRY SYLLABUS

(abstract)

THOMAS F. EGAN, S.J.

The three-fold objective as stated in the New York Province Syllabus is:

1) To introduce the student to the scientific method which, it is hoped, will arouse in him an intellectual curiosity, prompting him to seek explanations for observed facts.
2) To acquaint the student with the scientific laws and theories that are the foundation stones of modern chemistry.
3) To impart a factual knowledge of the properties and uses of the common elements and their chief compounds, with special emphasis placed on those that are of present-day industrial importance.

While these are a statement of aims drawn up by one province, yet they are such that they are substantially the same as the aims of the other two represented provinces in the field of high school chemistry.

To be specific, in the New York Province Syllabus, almost all the theoretical material is covered in the first semester, while the detailed study of the elements is left to be treated in the second semester. Inasmuch as only the second semester matter is used for the examination, there is a tendency to neglect the theory explained during the first semester with the result that preparation for the final examination consists of a long memory lesson of facts.

As a remedy for this situation, it is suggested that some of the theory should be shifted to the second semester, while the study of the individual elements should be made to depend as much as possible upon the theory. The Atomic Theory, Valence, Ionization and the Gas Laws could be treated in the first semester, and in order to insure a greater appreciation of the meaning and value of these theories, an attempt should be made to show how they were developed inductively from the observed facts.

LABORATORY SAFETY THROUGH HOME MADE MOVIES

(abstract)

FREDERICK J. DILLEMUTH, S.J.

One of the solutions to the omnipresent problem of instilling a safety-consciousness and also safe techniques and handling of apparatus in the mind of the neophyte chemistry student might well be a motion picture portraying the proper procedure as well as the dire consequences of careless manipulations. Since such a film is not, as far as the writer knows, available from a film distributing agency, the solution seems to be to "shoot" such a movie oneself. Other than the initial expense of several hundred feet of film and the procuring of a motion picture camera, the only effort would be the casting and actual filming of the picture.

The "set" for the film would be, of course, the laboratory. The cast would be select members of the chemistry class or the school dramatic society. It was suggested that color film be used because of its more universal appeal.

With regard to the scenes to be "shot" the following are suggested: proper handling of glassware, the correct method of inserting tubing through stoppers, the dangers of experiments carried on without the instructor's knowledge or approval, etc. The terrible consequences of unsafe procedures requires slightly more skill in filming and acting, e.g. interrupting the filming just before the "accident" is to take place, the proper makeup for the "victim", and careful editing of the film so that the scene appears continuous and not abrupt.

This type of film need not be restricted to safety techniques but could be used to portray proper procedures in other branches of science, v.g. the use of the analytic balance, distillation setups, micro techniques and a thousand others. Such a film, while taking time and ingenuity, would well repay the effort expended in its production.

Mathematics

APPLIED MATHEMATICS

(chairman's address)

REV. ANTHONY J. EIARDI, S.J.

"Mathematics is queen of the sciences and arithmetic the queen of mathematics. She often condescends to render service to astronomy and other natural sciences, but under all circumstances the first place is her due."

These words of the master mathematician, Gauss make me blush when I think of the general topic of today's meeting—Applied Mathematics. Mathematicians are gathered here to discuss the service of their field to other fields. Are they not squandering a rich opportunity to investigate their field, to study its structure, to penetrate into its essence? The answer is in the affirmative. An apology for this choice of topic should be made.

Mathematics is a living branch of knowledge. It is alive because it has almost continuous growth. Recent work appears in the mathematical journals, of which there are now about 500 published throughout the world. Some come out monthly, others quarterly, and the contents of about 200 are almost exclusively accounts of current mathematical research. So vast is the increase of mathematical knowledge from year to year that professional mastery of the whole domain of modern mathematics would demand the lifelong toil of 20 or more richly gifted men. And are we to penetrate into the essence of mathematics during the period of a meeting?

If we hope to investigate this morning the structure of the whole domain of modern mathematics, we should ascend the loftiest peaks to gain a panoramic view of the entire field. When we think we have ascended the highest range, we see loftier ranges. And down in the valley roads of progress cross and move away in every possible course. Specialization in any field has become altogether too specialized. Some one has written that out of the 50 mathematical papers presented in brief at a meeting, it is a rare mathematician indeed who really understands what more than half a dozen are about. The very language in which most of the other 44 are presented goes clean over the head of the man who follows the 6 reports nearest his own specialty. So for the time allotted today, we could only hope to ascertain again that there are 4 major divisions of modern mathematics: higher arithmetic, geometry, algebra, and analysis; hardly can we penetrate into the structure of a single division or the whole field of mathematics. This problem becomes more complex if mathematical physics be annexed as a province of mathematics.

We are teachers of mathematics and as teachers are primarily interested in instruction rather than research. When the application of a mathematical concept is offered a group of students, the instruction improves and the students appreciate better the significance of the mathematical concept. A teacher of Higher Algebra might devote several hours to the concept of invariance. The class will master the technique, but would they not appreciate the concept more deeply if it is pointed out how the idea of invariance permeates modern physics? Herein is our apology for today's topic. If the discussions send us back to the classroom better teachers, today's meeting will be worthwhile.

DISCUSSION ON THE APPLICATIONS OF ANALYSIS

(abstract)

Rev. George A. O'Donnell, S.J.

Although Analysis is generally considered to be on the graduate level, its foundations are laid in Algebra and Analytic Geometry. There are a great many applications for Analysis in Electromagnetics, Hydrodynametics and in general where there happens to be a sewer and a sink. In the advanced treatise of algebraic functions and intercepts it supplies ways and means of evaluating certain types of integrals with a vast range of application.

DISCUSSION ON THE APPLICATIONS OF DIFFERENTIAL EQUATIONS

(abstract)

Rev. Edward B. Berry, S.J.

In the discussion on Differential Equations, Fr. O'Donnell was asked to point out some authors whose works gave abundant applications. He mentioned Franklin, "Differential Equations for Electrical Engineers" and "Methods of Advanced Calculus", Chapter 9; Phillip, "Differential Equations"; Reddick, "Differential Equations"; Hitchcock and Robinson, "Differential Equations in Applied Chemistry".

Fr. Sohon pointed out that the same differential equation solves analogous problems in different branches, such as for a seismometer and an electric circuit having inductance, for capacity and resistance, for the loading of their rods and the motion of a rigid body, for certain elastic and hydrodynamic problems.

DISCUSSION ON THE APPLICATIONS OF GEOMETRIES

(abstract)

Rev. Timothy P. Reardon, S.J.

Geometries were classified on admission or denial of postulates. From Euclidean Geometry, all mensuration formulae of elementary, plane and solid geometry were used in science and engineeering. From Non-Euclidean Geometry applications were made to the Theory of Relativity. The axiomatic method as used in Geometry can be applied to all mathematics. From Affine geometry there are applications to Homogeneous strain. The Erlangen Program of Klein (1874) classified geometries by properties invariant under various transformations. On this Fr. Sohon noted the Cayley-Klein discovery that the log of the cross ratio is the unifying principle. An article on this was written by Fr. Sohon in this BULLETIN. On this Fr. Steele noted that such invariance had been noted previously by Apollonius and Pappus. From projective geometry applications are made to engineering drawing through descriptive geometry and also cartography. Fr. Steele noted that the axiomatic method is not a distinctive contribution of Euclidean Geometry. The original Euclid applies the method to numbers as well as to Geometry.

DISCUSSION ON THE APPLICATIONS OF TRIGONOMETRY

(abstract)

JOHN W. GREEN, S.J.

Trigonometry is used in Navigation for finding the position of the point at which the sun crosses the horizon and the time at which the sun rises. In Applied Mechanics right triangles are used in the solution of force problems where the forces are working at right angles. Radians are used in Engineering to determine gear rotations. The sine function is used to determine instantaneous voltage and current and to determine resultant current waves. The rotating arm of the resultant sum curve can be obtained by solving the right or oblique triangle which has for sides the rotating arms of the two original curves. Power factor angles and the power factor are found by right triangles. The problem of boring equally spaced holes around a circle is precisely that of constructing a regular inscribed polygon. The checking of a V-block, a dovetail or similar forms by means of cyclindrical plugs is done by recognizing the tangents to the circle and forming the proper right triangles. Many gages have outlines consisting in part of straight lines and circular arcs which are tangent. To find the location of a target or the burst of a shell as well as the location of inaccessible points, the sine function is used.

DISCUSSION ON THE APPLICATIONS OF VECTOR ANALYSIS

(abstract)

REV. FREDERICK W. SOHON, S.J.

Vector Analysis is taught as an introduction to Mathematical Physics. According to the author's viewpoint, the directed quantities of Mathematics and Physics have common traits, and so can be considered as having a common genus. If the term vector is taken as the name of the Common Genus, then the symbols used in their analysis will represent immediately the directed quantities of mathematics or of physics as these occur in the problem in the concrete, and will represent vectors only because these quantities are vectors. This is in contradistinction to other forms of analysis, in which the symbols do not represent the physical quantities themselves, but represent sets of members associated with these physical quantities.

"WHAT ARE SINES SINES OF?"

(abstract)

REV. ARTHUR STEELE, S.J.

This Short Note carried out the arithmetisation of the circular functions as an illustration of the chapter on linear differential equations with constant coefficients.

On the strength thereof, pretendedly new functions $s(x)$ and $c(x)$ were introduced as THOSE solutions of $f''(x)+f(x)=0$ whose initial values were 0 and 1, whose initial derivatives were 1 and 0 respectively. All others were identified as $f(0)c(x)+f'(0)s(x)$. The ADDITION and various other theorems were now won from the fact that $s'(x)$ and $s(x+k)$ and other functions are again also solutions. The power series for real x were obtained from the sequence, with principle soon transpiring, which is here set down:

$1 - c(x)$, $\quad 1 - x^2/2! + x^4/4! - c(x)$,
$x - s(x)$, $\quad x - x^3/3! + x^5/5! - s(x)$,
$-1 + x^2/2! - c(x)$, $\quad -1 + x^2/2! - x^4/4 + x^6/6! - c(x)$,
$-x + x^3/3! - s(x)$, $\quad -x + x^3/3! - x^5/5! + x^7/7! - s(x)$, etc.

The first term is non-negative and the derivative of the second. This second, being null at the origin and increasing, is also non-negative over the positive axis. It is also the derivative of the third—and so we can proceed, confining $s(x)$ and $c(x)$ between consecutive segments of the sine-series-to-be and the cosine-series-to-be. These series are everywhere uniformly convergent, wherefore and so on. Later on, short steps lead to periodicity and other properties. Finally, since e^{ix} and e^{-ix} also constitute a fundamental system of solutions, they and our $s(x)$ cum $c(x)$ are mutual linear composita with easily ascertained coefficients.

But what about High School sines and cosines? First, their geometrical specification must be cleaned up. Then, we find that they too solve the above differential equation with the above initial conditions. Uniqueness thus entails identity.

This is not suggested as an alternative to High School exposition as such. It is suggested as an illustration, in the course on differential equations, of how these equations help investigate new functions, or put old functions in a new light.

Finally, to answer the title question: SINES and COSINES are never of angles, but always of numbers. Each number has an appropriate sine and cosine of its own. Indeed, a complex number can have a real sine greater than 1. The sines and cosines in the tables register the sines and cosines of the NUMBERS which measure the corresponding angles. They do this only if that measure is radian measure. To name degrees and minutes and seconds in printed tables is merely to translate the side entries into engineer's units.

Sines are of NUMBERS, and NOT of angles!

THE EVOLUTION OF THE DETERMINANT

(abstract)

RICHARD J. ROSZEL, S.J.

The first notion of determinants may be attributed to the Chinese who in the eleventh century B.C. solved two linear equations in two unknowns by a rule equivalent to the method of solution by determinants. Oriental historians hold that Seki Kowa, the Japanese, in

1683 employed the same solution. Western historians reduce his method to the "exhaustion" theorem employed by the early Greeks for finding the area of a circle. History books more generally attribute the discovery of determinants to Leibniz in about the year 1693, although he never developed the subject further. The year 1750 saw Gabriel Cramer rediscovering determinants and inferring *without proof* the general solution of n simultaneous equations in n unknowns. In 1772 Laplace presented his rule for expanding the determinant by complementary minors, to be followed in 1812 by Cauchy who developed the long neglected general proofs of the basic theorems. Jacobi published his monograph in 1841 which included his own functional determinants in derivative form. About the same time Cayley invented the standard notation of a square array between vertical bars. From this swarms of special determinants were derived by writers on the subject with little thought toward utility. Finally in 1920 Muir published his five volume opus on the history of determinants, while the same year saw a more sensible absorption of the subject as a minor detail of advanced algebra.

Sources:

Hanus: The Determinant
Bell: History of Mathematics

A METHOD OF TEACHING WORD PROBLEMS IN ALGEBRA
(abstract)

WILLIAM J. EGAN, S.J.

This paper describes a method of presenting word problems in elementary Algebra, which attempts to simplify the formation of the equation. Using the well-known "box method" the student is taught to fill in the boxes in a definite order, and to find the equation in a definite place. The idea of the method is to avoid the common difficulty of not knowing where to begin.

A PROPOSED REVISION OF COLLEGIATE MATHEMATICS IN FIRST YEAR
(abstract)

EDWARD F. O'SHEA, S.J.

This paper treated of Mathematics in the Jesuit Colleges from the standpoint of Liberal Education and the diverse needs of the students who approach this discipline. Since it appears that mathematics of the traditional sort is not performing its wider educative functions for the non-specializing students of the Arts and Social Sciences, the question was raised: On which principles should a single mathematical college course be organized so that it serves as well as possible the educational interests of those students for whom it will most likely represent the end of their mathematical studies? The author attempted the formulation of such principles as ought to underlie the organiza-

tion of such a terminal course. Several texts, specifically written to meet the needs of these students, were then analyzed.

Reading of the paper was followed by a spirited discussion and an accepted proposal that a committee be appointed to study the problem further and present their findings at the next annual meeting of the Association.

The Committee will consist of the following members:
Fr. Arthur Steele, S.J., Fordham University
Fr. Timothy Reardon, S.J., Georgetown University
Mr. Edward F. O'Shea, S.J., Scranton University

Physics

QUESTIONNAIRE ON THE B.S. PHYSICS CURRICULUM
(report)

Rev. Robert B. MacDonnell, S.J.

Last Fall a questionnaire was sent to 20 Jesuits who are engaged in the teaching of physics at colleges in the three eastern provinces. The purpose of this questionnaire was to correlate their experiences as an aid in drawing up a physics program at Fairfield University. Answers were received from fourteen of those who received the questionnaire.

Some conclusions drawn from the answers were the following: (1) In none of the Eastern Jesuit colleges do the physics majors learn calculus in freshman year; (2) The lack of previous study of calculus proves a handicap in a specialized physics course in Sophomore; (3) Most recommended a single year of chemistry for physics majors rather than two years; (4) A course in applied mathematics in senior was quite generally approved, but the objection was offered that some graduate schools would demand a formal course in Vector Analysis and Partial Differential Equations.

The questionnaire revealed that Hausmann-Slack is the most popular textbook for physics majors, and that all but two of the eastern Jesuit colleges use their own laboratory notes for the course in General Physics. The introduction of a non-credit course in shop technique and glass blowing was recommended.

RADIOACTIVE TRACERS
(abstract)

Rev. John A. Tobin, S.J.

After a brief explanation of the structure of the nucleus, the chart of the isotopes was explained. The 750 "nuclides" or different kinds of nuclei were divided into stable isotopes, naturally radioactive isotopes and artificially radioactive isotopes. The nuclear "chess

game" explaining how the nuclei change and how they send out particles that can be detected was demonstrated on the chart. The use of electrons, neutrons, protons, deuterons and alpha particles as particles shot at the nucleus and the induced reactions were explained by equations. The simple neutron capture, or the neutron capture with particle emissions, the bombardment by deuterons and the emission of protons, or neutrons or alpha particles, and the reactions induced by alpha particles and protons were shown in the new simplified equations. These artificial radioactive isotopes of the elements are indistinguishable from their ordinary stable relatives until they manifest their radioactivity. When a ten dollar bill is marked it can be traced and used as a ten dollar bill. In the same way these radioactive isotopes may be used and detected by geiger counters, in a complicated and involved chemical or biological process. Examples were given of the use of radioactive iodine in the study of the thyroid function, and radioactive strontium in the studies of bone metabolism. Another method is radio-autography. The use of radioactive zinc absorbed by a tomato plant, although only present in a few parts in a million, gave off energy to a photographic plate, and showed the distribution of the zinc in the fruit. By these radioactive isotopes the rate at which sap rises in plants or the rate at which blood flows through the veins can be measured. Radioactive carbon is being used to study the process of photosynthesis.

A NEW TENSOR FORCE MODEL FOR THE DEUTERON
(abstract)

WILLIAM G. GUINDON, S.J.

Several simplified models for the neutron-proton interaction have been used in investigations in which the measured properties of the neutron, proton, and deuteron, and the low-energy neutron-proton and proton-proton scattering cross-sections are used to determine the constants in the assumed potentials. Rarita and Schwinger[1] used a square-well model in which the ranges of both tensor and ordinary forces are the same. A recent study[2] has been made with a model in which the tensor force has a different range from that of the ordinary force, although the latter range is identical for both singlet and triplet states. More recently a study[3] of the experimental data relative to scattering processes shows that, for square-well potentials, the singlet range must be considerably smaller than usually assumed, and the effective triplet range much smaller still. Accordingly an attempt to fit experimental data with a model embodying these specifications has been begun. Preliminary results indicate that this model gives too small a value for the quadruple moment of the deuteron.

[1]W. Rarita and J. Schwinger, Phys. Rev. *59*, 436 (1941).
[2]W. G. Guindon, S.J., Phys. Rev. *74*, 145 (1948).
[3]J. M. Blatt, Phys. Rev. *74*, 92 (1948).

PULSE TECHNIQUES IN ULTRASONICS

(abstract)

JOSEPH F. MULLIGAN, S.J.

In measuring the velocity and absorption of ultrasonic waves two methods are used: (1) An optical method, in which the ultrasonic beam acts as an optical diffraction grating; (2) An electrical method, employing the acoustic interferometer. In recent years the electrical method has been modified by the use of "pulse" techniques developed from radar. Here the quartz crystal which is the source of the ultrasonic waves emits them for a time of the order of one microsecond. The velocity of this sound pulse can then be determined by measuring the time it takes for the pulse to travel through the medium to a reflector and return to the crystal. Absorption determinations are made by observing the change in amplitude of the pulse. Both these determinations can be made directly with the aid of a radar-range oscilloscope. Pulse techniques have led to the development of commercial instruments, such as the "Supersonic Reflectoscope", for the location of flaws in solids.

A NEW EXPERIMENTAL METHOD FOR THE DETERMINATION OF CENTRIPETAL FORCE

(abstract)

FREDERICK L. CANAVAN, S.J.

A new type of centripetal force apparatus was demonstrated. This apparatus measures the centripetal force involved in a swinging pendulum and is superior to the other types on the market in that it does not require expensive apparatus or delicate manipulation.

THE RATIO OF THE SPECIFIC HEATS OF METHANE FROM ULTRASONIC MEASUREMENTS

(abstract)

ROBERT O. BRENNAN, S.J.

Computations have been completed from a notebook begun by Rev. T. H. Quigley, S.J., in the spring of 1947. The ratio of the specific heats of methane, c_p/c_v is determined in the range 100-250° K. at 1 atm. pressure from the velocity of sound measurements of Fr. Quigley (*Phys. Rev., 67,* 298) and specific volumes given by Corcoran, Bowles, Sage and Lacy (*Ind. and Chem. Eng., 37,* 825). The values of c_p/c_v fall along a curve consistently below values given in the literature.

In the course of the work, the "second virial coefficient" of methane is determined in the same range and compared with that obtained from critical data and Berthelot's equation as stated.

A BRIEF BIBLIOGRAPHY OF ULTRASONICS

JOSEPH F. MULLIGAN, S.J.

At the last meeting of the A.A.J.S. considerable interest was shown in the subject of ultrasonics* by members of both the physics and chemistry sections. The following brief bibliography may be of some help to those interested in this field.

Books:

Ludwig Bergmann, *Der Ultraschall und seine Anwendung in Wissenschaft und Technik.* Third edition, Berlin, 1942. (Lithoprinted by Edwards Brothers, Inc., Ann Arbor, Michigan, 1944.)

Ludwig Bergmann, *Ultrasonics and Their Scientific and Technical Applications* (English translation of the first edition of the above). New York, John Wiley and Sons, Inc., 1938.

Periodical Reviews:

J. C. Hubbard, "A Brief Survey of Supersonics", *Journal of the Acoustical Society of America, 4,* 2, 99-107 (October, 1932).

J. C. Hubbard, "Ultrasonics—A Survey", *American Journal of Physics, 8,* 4, 207-221 (August, 1940).

W. T. Richards, "Supersonic Phenomena", *Reviews of Modern Physics, 11,* 36-64 (January, 1939).

These books and articles give a good survey of the field and are not too specialized. More complete and specialized bibliographies are to be found in the article of Richards and in Bergmann's book. Richards gives a critical bibliography of the field up to 1939. Bergmann lists over 500 periodical articles on ultrasonics in his first edition (1937). In the third edition (1942) this bibliography has grown to over 1,000 references. This indicates how rapidly the field of ultrasonics is growing.

BIBLIOGRAPHY OF MAGNETOSTRICTION

(notice)

REV. BERNARD A. FIEKERS, S.J.

A seven-page hectographed bibliography with latest correction to February 1947 may be obtained gratis from Mr. William A. Mudge, Director of Technical Service on Mill Products, the International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

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*According to a convention recently adopted the name "ultrasonic" is applied to longitudinal waves whose frequencies are above the audible range, and the name "supersonic" to velocities greater than the velocity of sound. That this usage has not always been followed is clear from the titles of the articles above, all of which deal with "ultrasonic" phenomena.

MEASUREMENT OF TEMPERATURES IN THE VICINITY OF ABSOLUTE ZERO

(abstract)

JOHN F. DEVANE, S.J.

The magnetic susceptibility of certain paramagnetic salts is the parameter used to determine temperature in this region where the regularity of a helium gas thermometer breaks down. Temperatures are then indicated on the Curie Temperature Scale and one method of converting Curie Temperatures to Absolute Temperatures was discussed.

THE NEW ELECTRICAL UNITS

REV. HENRY M. BROCK, S.J.

By Act of Congress, July 12th, 1894, the Practical International Electrical Units recommended the previous year by the International Electrical Congress in Chicago became legal in the United States. They represented as closely as was then possible the Practical Absolute Units based on the C.G.S. System proposed by a Committee of the British Association in 1862. With the advance of Electrical Science it became evident that discrepancies existed between corresponding units of the two systems. In 1935 the International Commission on Weights and Measures meeting in Paris recommended that new determinations be made of the ratios between the absolute and the corresponding international units in the National Laboratories and that the practical absolute units be substituted for the old system on January 1st, 1940. On account of conditions due to the war our National Bureau of Standards did not make the change until January 1st, 1948.

The Leeds & Northrup Company and the Weston Electrical Instrument Company are making the changes in their new instruments when necessary and doubtless other manufacturers are following suit. The change in units will have little effect as far as instruments now in use in our Laboratories are concerned. For accuracies up to 0.1% the differences are negligible. When an accuracy of 0.05% or better is sought the necessary correction should be made. But this rarely occurs. The L. & N. Type K Potentiometer is one of the few instruments which will easily give this accuracy when used to measure electromotive force and current. Since it is essentially a ratio instrument it may be used with either system of units. The makers are extending the Standard Cell scale in their new instruments since the Absolute voltage of the Weston Cell is slightly greater than the old value. However, at Weston we find that our Potentiometer can be set at the Absolute voltage of a recently rebuilt Standard Cell. When using the instrument to measure current with a standard resistance the latter should be corrected when an accuracy of 0.05% or better is sought.

A METHOD OF TEACHING THE BASIC MECHANICAL UNITS TO STUDENTS OF ELEMENTARY MECHANICS

(abstract)

JAMES J. RUDDICK, S.J.

A method of teaching the basic mechanical units was presented. The method employs an arrangement of all of the force problem units into five systems, three absolute and two gravitational. After the students have studied the standards of length and mass, acceleration, the laws of falling bodies, and Newton's first two laws, they are shown how to apply the second law to obtain the five consistent sets of units. Special attention is given to the relationship between the mass pound and the force pound.

Science and Philosophy

THE HEISENBERG PRINCIPLE

(abstract)

REV. JOSEPH P. KELLY, S.J.

The Heisenberg Principle of Indeterminism is a scientific principle and based on measurement. According to this principle it is impossible to define (measure) with accuracy the simultaneous position and velocity of a sub-atomic particle, e.g., an electron. The more accurately one measures the position the less accurately can the velocity be measured and vice versa. The spacio-temporal determinism of these particles demands both measures and they are called "complementarities"; neither alone suffices.

These notions have been extended to other physical phenomena, e.g., light phenomena, so that the wave-corpuscle interpretation assumes this complementarity aspect. In a similar manner the application has been extended to other phenomena involving a unified group of physical entities into a system. In all such cases the principle involved seems to be: the more one emphasizes one aspect of the phenomenon, the more one recedes from the other; the more accurately one is measured the less accurately the other and vice versa.

A further extension of the principle may be found, according to some scientists, in the field of human and social thought where we find relationships between individuals and groups or societies. When we speak of the group as such we submerge, as it were, the individuals and on the contrary, to make particular note of the individuals detracts from the group-idea. While there is a face-value similarity here, it is to be noted that the immense difference between

human beings and inanimate physical particles should warn us not to press the analogy too closely. Moreover, since the methodology of the sciences is based chiefly on measurement and is quantitative, we cannot extend this method into other branches of knowledge without the modifications demanded by the diverse approaches to reality.

Abstracted Report

The Twenty-five Volume Index of the Bulletin

The manuscripts of the subject index of the first twenty-five volumes of the BULLETIN have been completed. The cards used for this compilation can be used for the erection of an author index as well. But the advisability of publishing an author index is being debated and will depend largely on the reception accorded the subject index.

If the subject index were to be published in mimeographed form it would require about fifty pages of double columns, in single spaced elite type. Some of the problems confronting the committee are as follows: the desirability of an author index; the possibility of binding the proposed subject index; the circulation problem; the choice of merely duplicating the index or having it printed; and, the financing of the project.

ROBERT O. BRENNAN, S.J.
FREDERICK L. CANAVAN, S.J.
REV. BERNARD A. FIEKERS, S.J., Chmn.
JOSEPH F. MULLIGAN, S.J.
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Total membership numbers one hundred and eighty-seven. Eighty-six attended the twenty-third annual meeting. The editor will be grateful for having any errors of commission or omission called to his attention.