S.J.B

A. M. D. G.

# BULLETIN

*of the*

# American Association of Jesuit Scientists

(Eastern Section)

Founded 1922

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LOYOLA COLLEGE

BALTIMORE, MARYLAND

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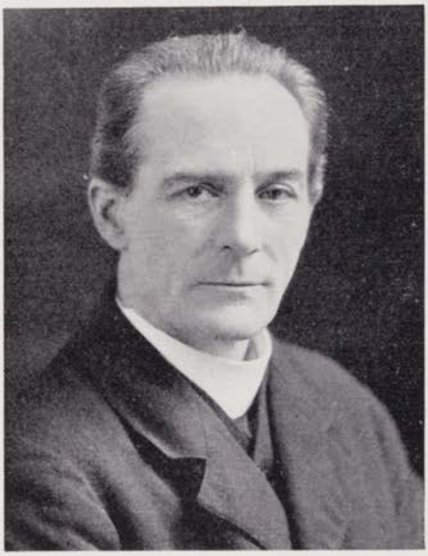
# Bulletin of American Association of Jesuit Scientists

EASTERN STATES DIVISION

Vol. XVII DECEMBER, 1939 No. 2

# REV. WILLIAM J. O'LEARY, S.J.

## 1869 - 1939



Father William J. O'Leary, S.J., was born at Dublin on March 19th, 1869, a son of Dr. W. H. O'Leary, M.P., a leading surgeon, Professor of Anatomy in the Royal College of Surgeons, Dublin, member of the Irish Party in the House of Commons and, remarkably enough, a friend of both Gladstone and Disraeli. He was educated at Tullabeg and Clongowes Wood Colleges and entered the Jesuit Order in 1886. He showed a marked capacity for scientific work and, as a young man at Louvain, received a solid foundation in Mathematics, Physics and Astronomy. He spent many years teaching Mathematics and Physics in Colleges in Ireland. He was a very successful and stimulating teacher and his gift of lucid exposition is well shown in a text-book on Mechanics published in 1900.

His mind ran on original lines. He was never content with stereotyped text-book solutions, he had to work out each problem for himself from first principles. In this way he was able to study many questions from a fresh angle and to develop original lines of research in various branches of science. Combined with this was a highly developed inventive talent and the ability to design new instruments and the skill to construct them.

In 1909 he set up a finely equipped meteorological and seismological observatory at Mungret College, Limerick. At the request of a Joint Committee of the British Association and the Royal Meteorological Society he carried out from 1911 to 1914 a series of upper air investigations by means of sounding balloons. These were the furthest west observations made in Europe. The results attracted considerable attention at meetings of these Societies and were published by them.

One of the main problems in seismometry is to obtain an instrument with a fairly long period and consequent high sensitivity. Father O'Leary provided a satisfactory solution with his two component horizontal seismometer with trifilar suspension. Leading seismologists, such as Professor Milne and Prince Galitzin, had high praise for the neatness of the invention. He completed one of these instruments in Mungret in 1911. In 1915 he started a seismological observatory at Rathfarnham Castle, Dublin. The O'Leary seismograph there, constructed by himself, with a moving mass of 1½ tons, has given excellent service ever since. At the British Association meeting in 1913 he showed plans for a new type of seismograph, a three component one with photographic recording. Sir Howard Grubb, then of Dublin, arranged to construct this instrument, but the out-break of war prevented a start being made; the firm was fully occupied with war work, and the seismograph was never built.

The need for accurate timing in seismology turned Father O'Leary's attention to chronometry. As usual he went to the root of the problem. He soon saw that the secret of precision timing was to be sought in a free pendulum. He was, indeed, one of the pioneers in the development of the free pendulum clock. A clock, patented by him in 1918, shows a definite advance in the method of synchronizing the slave-clock and the free pendulum, by introducing a positive error in the slave-clock (so that it always ran a little fast) and wiping it out every half minute. Father O'Leary did not consider this an ideal arrangement and set to work to improve on it. In his later models it is immaterial whether the slave goes fast or slow, and correction is made, not every half-minute, but only when the slave is fast or slow. A clock of this type, beautifully made by him, has given good service at Riverview Observatory. Apart from various patent specifications, no description of the clock has yet been published.

In 1929 Father O'Leary came to Australia as Director of Riverview College Observatory, in succession to Father E. F. Pigot, S.J.

Besides introducing various improvements in the seismological department (he promoted, for example, the more rapid interchange of results between the various Pacific stations), he initiated a programme of photographic research on variable stars in collaboration with the Bosscha Observatory, Lembang. Though he commenced this work so late in life, he developed new methods and devised new instruments. He invented and built a blink comparator which has proved very successful in searching for new variable stars. A few days before he died he completed a comparator of another new design. He discovered many new variable stars and published several papers on variables in the publications of the Riverview and Lembang Observatories and in the Astronomische Nachrichten.

Among various other inventions may be mentioned a recording anemometer and a petrol gas-plant. He was always most generous in handing on to others his ideas and unpublished work; for instance, more than one standard type of seismograph owes something to his inventive brain.

Father O'Leary was a most attractive speaker. His lectures on astronomy and seismology were greatly appreciated both by scientists and by the general public. His light and humorous touch combined with his clarity of exposition to render even abstruse topics intelligible and interesting. With all these activities he still found time to do much good work as a priest. Many people in various parts of the world will be grateful to him as an instructor and a wise counselor. A wide circle of friends mourn the passing of a very attractive character.

Death came suddenly on April 16th, from a heart attack. He knew of this weakness and faced the prospect of a sudden death with perfect equanimity and cheerfulness, though he was so active that his friends hoped that he would be spared for many years. He retained his freshness of mind and originality until the end. Death interrupted plans for fresh researches in astronomy and seismology and for new instruments—a new type of vertical seismometer, a projection comparator, further improvements in his free pendulum clock. The day before he died he discovered a number of new variable stars with his newly completed comparator and that night worked at the telescope taking star photographs.

He was a Fellow of the Royal Astronomical Society, a Member of the Royal Irish Academy, the Royal Society of N.S.W., the Societe Astronomique de France, the Seismological Society of America, Past President of the N.S.W. Branch of the British Astronomical Association and member of the Australian National Committee on Astronomy.

D. O'CONNELL, S.J.,
Riverview College Observatory,
Sidney, Australia.

*Speech by Mr. J. Nangle, Government Astronomer, at a meeting of the N.S.W. Branch, British Astronomical Association, April 26, 1939.*

The President said he regretted to have to report that since the last meeting the death of the Reverend Father O'Leary had taken place. By the passing of Father O'Leary the community had lost a good citizen, Astronomy had lost a distinguished worker and members of the Branch had lost a very dear friend. It is now some years since Father O'Leary became Director of the Riverview Observatory. The late Father Pigot, who was his predecessor, established the Riverview Observatory and Seismological Station on a very high footing. Father Pigot was not easy to follow, but it is pleasing to be able to say that Father O'Leary did succeed in being a worthy successor and had even raised the standard of the well known Observatory of which he has been Director for so many years. He will be remembered in the scientific world for his work on Variable Stars at Riverview.

The members of this Branch have had many opportunities of listening to his lucid descriptions of Astronomical problems, and the public of N.S.W. will long remember his informative, delightful lectures given under the auspices of the Royal Society of N.S.W. Father O'Leary had the great gift of intermingling much humor when describing scientific facts during a lecture. The gift of describing matter-of-fact things in a very attractive way and with humour is possessed by only the very few. Of the few Father O'Leary was outstanding.

In addition to his priestly duties and his scientific work, he was able to find time to do some excellent work in the way of making clocks and scientific instruments. Father O'Leary was an authority on clocks and made not only for his own Observatory, but for at least one Observatory abroad, free pendulum clocks of most excellent design and workmanship. At the time of his death he had completed a Blink Comparator for use in examining photographs of Variable Stars.

Father O'Leary presented to all who came in contact with him a most attractive and likable personality. He was extremely alert in all his thoughts and actions, but smiling always, so that it was impossible to be long in his company without being affected by his pleasing temperament. So constant was he in his bright outlook on life that it is easy to imagine him smiling and optimistic to the last moment. The loss we feel is tempered by the fact that we can imagine him vivacious until the moment of his death and we are consoled that he went without suffering.

# REV. ALOYSIUS B. LANGGUTH, S.J.

## 1889 - 1939

At the early age of fifty, leaving a keen sense of irreparable loss among his associates and former students, Father Aloysius B. Langguth, S.J., was summoned to his reward on March 11, 1939. As was clearly evidenced by the thousands of enquiries for him during his long and final illness, Father Langguth had been held in esteem and deep affection not only in his own Province of New England but in the other provinces as well wherever there were those who had enjoyed the blessing of his acquaintance.

A native of Boston, where he was born on March 11, 1889, young "Al" entered Boston College High School and continued on through Boston College to his graduation with the bachelor degree in June 1910. Two months later, on August 31, he entered the novitiate at St. Andrew-in-Hudson to begin his career in the Society of Jesus for which he so eminently qualified. Deeply fervent without ostentation, serious but not severe, warmly sympathetic and cheerful always, the new novice was soon appointed beadle to the delight of his fellow novices. Advancing in due course to the Juniorate for one year, thence to the study of philosophy at Woodstock, where he specialized in Chemistry, he was first assigned as Professor of Chemistry at St. Joseph's College whence after two years he was transferred for another two years in the same position at Georgetown University.

Returning to Woodstock for theology, none the less seriously religious for the years he had devoted to chemistry, Father Langguth came finally to the crowning joy of his life, his ordination to the Holy Priesthood on June 20, 1923.

Having completed his studies Father Langguth was returned once more to his chosen field, this time as Professor of Chemistry at Canisius College, a post he relinquished after only one year in generous response to the united calls of the Holy Father and Reverend Father General for volunteers so urgently needed in the Philippines. His broad shoulders, however, and his rugged frame were unequal to his unlimited generosity with the consequence that after two years of arduous labor as Professor of Chemistry at the Ateneo de Manila his health was broken and he was obliged reluctantly to surrender his post and return to the States. The finely equipped department of chemistry at Holy Cross College was next to benefit for five years by Father Langguth's capable direction, and finally Boston College shared the fruits of his labors as he continued as Professor of Chemistry, again in charge of the department.

To his chosen field in chemistry Father Langguth might be said to have contributed nothing if achievement were to be measured in terms of published research. Unlike his more famous contemporaries, Father Nieuwland of Notre Dame and our own Father Coyle, he failed to appear on the programs of conventions of chemists and his name is missing in the files of chemical literature. Nonetheless, he was indeed their peer, since no less ably and devotedly than they he gave himself to his students and to their advancement in the field of chemistry, a living contribution to chemistry far transcending the ultimate in the line of research.

Loved and esteemed by his students no less than by his fellow Jesuits, Father Langguth will be long remembered lovingly as an exemplary religious and as a gifted and inspiring teacher. May he rest in peace!

REV. JOHN P. DELANEY, S.J.,
Loyola College.

# REV. MIGUEL SADERRA MASO, S.J.

## 1865 - 1939

Father Miguel Saderra Maso, S.J., connected with the Manila Observatory for over thirty years, died at 10 h. 43 m. a.m. on March 21st at the Hospital Español de Santiago in San Pedro Macati. Father Saderra Maso was born on December 13, 1865, at San Cristobal las Fonts, Olot, province of Gerona, in Spain. Having attended the schools of his native town, Fr. Saderra transferred to the Seminary of Gerona and entered the novitiate of the Society of Jesus at Veruela, Aragon, on September 26, 1882. On July 25, 1890, Fr. Ignacio Vila, now residing at Dapitan, Br. Ramon Morros, long since dead, and Fr. Saderra left Barcelona for Manila on board the steamer "*Panay*". After six years of scientific work in the Observatory of Manila, Fr. Saderra sailed from Manilla on September 3, 1896 on the same steamer on which Dr. Rizal was returning to Spain. On the completion of the required high ecclesiastical studies, Fr. Saderra was raised to the priesthood by Rt. Rev. Pedro Rocamora, Bishop of Tortosa. Before his return to the Philippines, Fr. Saderra spent two years in France and India, persuing scientific studies, mainly related to magnetism and seismology. For over thirty years ending in 1931, Fr. Saderra was associated with the Manila Observatory and rendered invaluable service to the people. He was instrumental in the erection of the seismic stations of Guam, Butuan, Ambulong and Baguio. As a result of painstaking reading and research, he published *La Seismologia* en Filipinas in 1895 and a more detailed catalogue of Philippine earthquakes in 1926. He contributed to the Census of 1903 by the preparation of a special report on Philippine volcanoes. To Fr. Saderra, the agriculturists are indebted for his report on the Rainfall of the Philippines, the geologists for his report on the connection between geology and earthquakes and the weather observers, for his Practical Instructions on Meteorology. There is hardly any island of considerable size in the Philippines that Fr. Saderra had not visited either to establish a weather station or to observe a seismic or volcanic phenomenon, as the earthquakes of Batanes, or the eruption of Taal or Bulasan or the typhoon of Cebu in 1912. In 1902 he directed a magnetic survey of the island of Mindanao. Twice every month for twenty years Fr. Saderra and party went to Antipolo to make magnetic observations and provide the fundamental data necessary in the magnetic survey of the islands. The Jesuits of the Philippines will remember Fr. Saderra as the author of "Misiones Jesuiticas," the inhabitants of the district of La Ermita as the author of "Nueasta Señora de Guia," those devoted to Antipolo as the author of "La Virgen de Antipolo," and friends of the observatory as the author of "Historia del Observatorio, 1865-1915." In 1920 he represented the Manila Observatory at the First Pacific Science Congress in Honolulu.

Of few people can it be said with greater truth that they died in the line of service. On October 17, 1931, a severe typhoon was approaching Balintang Channel. Fr. Saderra, as chief of the Meteorological Division, penned a typhoon warning to the steamer "Taurus" in the vicinity of Aparri. He had hardly finished the message when he felt the first stroke that paralyzed half of his body and he had to be led to his bed. That was the last typhoon warning he ever signed. That was also the beginning of a series of strokes that lasted seven years and ended today.

WILLIAM C. REPETTI, S.J.
Manila Observatory, P. I.

# SCIENCE AND PHILOSOPHY

## A LETTER TO THE REV. EDITOR OF THE BULLETIN OF THE AMERICAN ASSOCIATION OF JESUIT SCIENTISTS

Reverend and Dear Father Editor;—

Almost from its inception, the Bulletin has contained sporadic attempts at a rapprochement between the Philosopher and the Scientist. Six years ago, in the December issue, Vol. XI, No. 2, 1933, we committed ourselves to a definite department of Science and Philosophy. The venture was begun with some trepidation perhaps, but with vast faith and courage. If the success of this new department is to be judged by the quantity and the variety of article published, one can scarcely doubt that our hopes have been well realized. We can feel safe that we are following the proper trend of thought in our discussions. For, in the issue of December, Vol. XVI, No. 2, 1938, we read the report of Rev. Th. Wulf, S.J., to the twenty-eighth General Congregation of the Society of Jesus, "on the necessity of combating modern errors scientifically." Among the "subjects of error" mentioned by Fr. Wulf, are: The Constitution of Matter, Space, Time, Causality, Natural Law and our Certitude of the External World. It is especially gratifying for us to know that these problems have not been neglected by the contributors to the Bulletin.

Reviewing the labors of the past six years, it may come as a matter of surprise to many of the readers to see that about *forty* articles on Science and Philosophy have appeared in the Bulletin. Nearly one half of them have been devoted to the general problems and the rest to specific questions of common interest to the Scientist and the Philosopher. We need no stronger proof of the interest that has been shown by Ours in these borderline disciplines. Our writings have treated such general questions as: The Relations of Science and Philosophy; the Philosophy of Mathematics; the Philosophy of Measure; Philosophy and Biology; Scientific Definitions; Science, Metaphysics and Human Knowledge; Research and Bibliographies. The special topics include: The Constitution of Matter; Mass and Matter; Order; Space; Causality; Laws of Nature; Statistical Laws and Vitalism. In these we have given a wide scope to our activity and have chosen problems which have current interest.

That the Philosophy of Science occupies a foremost place in modern thinking, will be readily admitted. The flood of literature from both scientific and philosophical sources bears ample testimony. The well-attended, popular lectures on these questions manifests a curiosity, if not a desire of knowledge, on the part of the "man of the streets." We, on our part, have many advantages; we hold an almost unique position in that we have a solid, philosophical background for analyzing and discussing these mooted questions. We are practically alone in possessing a unified and systematized philosophy whose principles comprehend the universe. This does not mean that we have reached the final solution of the riddle of the universe but we have principles and a system of thought that offers a fecund means for a consistent Philosophy of Science. Many modern philosophers and scientists are directing their attention to Scholastic Philosophy and the method employed by the Schoolmen for the interpretation of the world about us. References are made to Aristotle, St. Thomas and St. Albert, the Great, which were hardly possible at the turn of the century. The failure of the physical sciences to present an adequate answer to the world-problems have brought a realization that these same sciences require a supplement from philosophy to satisfy the natural tendencies of the human intellect. Hence, they are looking to philosophy to aid in the systematic understanding of the universe. As Eddington says: "We recognize that the type of knowledge after which the physicist is striving is much too narrow and specialized to constitute a complete understanding of the human spirit." (1) And Heisenberg: "Many of the abstractions that are characteristic of modern theoretical physics are to found discussed in the philosophy of past centuries. At that time these abstractions could be disregarded as mere mental exercises by those scientists whose only concern was with reality, but to-day we are compelled by the refinements of experimental art to consider them seriously." (2)

The task that faces us is not merely a restatement of the theses propounded by the Master Scholastics; it is rather a deeper understanding of the principles that formed the basis of their system of thought and the application of these principles to the newly-found scientific problems. In the work already completed, we have laid a firm foundation. There remains for us the erection of the superstructure of an adequate Philosophy of Science. Prosit.

JOSEPH P. KELLY, S.J.,
Weston College,
Weston, Mass.

(1) Eddington. "New Pathways of Science." p. 316.
(2) Heisenberg. "The Physical Principles of the Quantum Theory."

# PIUS TWELFTH'S ATTITUDE TOWARD SCIENCE

REV. ROBERT B. EITEN, S.J.

After any Pope's death, and this was especially true after the death of the late Pius XI, there is always much discussion as to who will be the next Pope. And when a new Pope is elected, then the general public begins to speculate about his future policies. Thus, immediately after the election of Pius XII, Nazi circles described the new Pope as "uncompromisingly anti-Nazi and anti-Fascist." Nor were the representatives of scientific circles completely silent. Although the late Pius XI learned from St. John Bosco ever to be "in the advance-guard of progress," yet after his death at least one prominent newspaper had the affrontery to state in words similar to the following that "Pius XII might bring the ancient church in line with the developments of modern science." Perhaps the writer of those lines never pondered as deeply as the great Nobel prize winner, Dr. Alexis Carrel, the shortcomings of material science when the latter wrote in his famous book, **Man, The Unknown**, (page 7):

> The conquest of the material world, which has ceaselessly absorbed the attention and the will of men, caused the organic and the spiritual world to fall in to almost complete oblivion.

But even apart from this, since there is such an intimate liaison between science and religions, so intimate, indeed, that Pius XI did not hestitate to affirm in his Pontifical Epistle "In Multis Solaciis" that the natural sciences "have been a guide for safeguarding the treasure of heavenly wisdom entrusted to the church," it is natural for us, therefore, to wonder just what "Pius XII's Attitude toward Science" is. Since the beginning of his pontificate, however, he has been prevented by the various war crises from giving to science and the other liberal branches of knowledge the time he would naturally like to give to them. But fortunately, the attitude of His Holiness towards science is readily known from the various speeches which he gave at scholarly circles prior to his election to the chair of St. Peter. Hence, we shall not blush to use long quotations from these speeches for they show more clearly the mind of His Holiness in his attitude towards science than any other interpretation or approach although the latter too will be used here.

First of all, our Holy Father's love of scholarship makes him a lover of science. It is said that while he was living in Berlin as papal nuncio, there was scarcely an important meeting of students and university professors—almost entirely Protestant circles—to which he was not invited and at which he was not made the object of highest regard.

The Holy Father, too, esteems genuine science because as a great lover of truth, he encourages any endeavor towards its development. The part which science plays in this search for truth he strikingly portrayed before the Pontifical Academy of Sciences (on May 31, 1937) when he said:

> . . . wherever man looks for and finds truth, from whatever river of creation, from the skies, the oceans, the terrestrial abysses, they [the rational and the natural sciences] may break forth and give light to the human mind, they prepare and build the access to the temporal faith, the steps to the sancta sanctorum behind whose veil are hidden the secrets of the Deity.

Furthermore, Pius XII realizes that science by reason of the wonders which it brings to light, brings its devotees to a homage of the Creator. Thus before the same learned body he said:

> . . . it is evident that his homage of created intellect will never be more worthy of the Creator than when it is illuminated by the splendors of science.

Nor could the personal contact—to say nothing of his filial devotion—which Pius XII, as secretary of state, had for nearly ten years with his predecessor, Pius XI, that great lover of science, fail to make a great impression on him. He was present at the third inaugural session of the Pontifical Academy of Sciences last December (1938), when during a 45-minute speech on Religion and Science Pius XI uttered these salient words:

> Everything has been made by the Verbum, by the great Fashioner of the universe; nothing can touch this expression in beauty and power; no other marvel except the same divine Word, in explaining the tremendous beauty of such work, could say elsewhere of God: "He has made everything in weight, number, and measure."
>
> It is like entering an immense laboratory of chemistry, physics, and astronomy; and very few can admire all the profound beauty of these words as they can who make a profession of science.

But if in the realm of science there is one thing which Pius XII has ever insisted on, it is that religion and science are not opposed in any way to each other. Speaking at the university of Notre Dame he uttered the following words which many other universities might well adopt:

> It is the teaching of this university that there is no conflict between science and religion. . . Science should go hand in hand with religion.

In his address to the Pontifical Academy of Sciences before such celebrities as Planck, Bohr, Birkhoff, Carrel, Schroedinger, to mention a few of those present, he was even more insistent on this matter. He knew, too, that Pius XI (who was then living) was the great proponent of this all-important truth. A part of his speech which is pertinent here runs as follows:

> In truth, there are many to whom science and faith spell an almost irreconcilable contrast. It is not so and it can not be so for the Holy Father [Pius XI] nor for those who consider that science is the quest for truth as it is to be found in the natural revelation of creation, and that faith is the homage of the created intellect to the truth directly revealed by the Creator.

On October 22, 1936, he gave a stirring address to a Convocation of more than 4000 members of the faculty and student body of the Catholic University of America and its affiliated institutions on religion and science. There he took pains to go into some detail on the relationship between religion and science. By reason of its striking clarity and precision the part of his speech devoted to this relationship shall be quoted here nearly in full:

> God the Creator, who is also the God of supernatural revelation, is the essential and inexhaustible font, embracing and sustaining all things in which all truth, natural and supernatural, has its source. The Divine Word, who operates in both spheres, speaks to us in different ways in the order of nature and in the order of grace, but the truths of one order can never be found in contradiction with the truths and mysteries of the other. In consciousness of the harmonious coordination and subordination of the truths of the natural and supernatural order, the thoughtful Catholic student finds the origin of that sense of spiritual steadiness and inner security which nothing in this world can replace, which constitutes his most precious heritage and is the privileged possession of those centers of learning whose breath of life is the Catholic faith.

But if our present Holy Father has a great love of science and is ever interested in its progress (for he knows that science, far from being opposed to religion will rather make religion shine forth in all its splendor), he is none the less cognizant of the fact that

> . . . technical organization, material invention and progress [can develop] a rhythm of life which can impair that harmony between the corporeal and the spiritual willed by Almighty God, and place men in danger of being enslaved by the material world instead of being its masters. (From address at Cath. U. of Amer.)

Nor is he alone among learned men in the realization of this danger resulting from an over-emphasis of mechanical inventions. To quote again the great scientist, Dr. Alexis Carrel, in his book **Man, The Unknown**, page 42 and 43:

> In truth, pure science never directly brings us any harm. But when its fascinating beauty dominates our mind and enslaves our thought in the realm of inanimate matter, it becomes dangerous. Man must now turn his attention to himself, and to the cause of his moral and intellectual disability . . . There is not the shadow of a doubt that mechanical, physical, and chemical sciences are incapable of giving us intelligence, moral discipline, health, nervous equilibrium, security, and peace.

To counteract any enslavement of man by science Pius XII would have us cultivate "a zeal whose glance is fixed on eternity, a generous and disinterested zeal for truth and the Catholic conception of life." (from address at Cath. U. of Amer.)

These few thoughts, I believe show rather clearly that the outlook of our present Holy Father towards science is both progressive and conservative. As a great lover of science, he is intensely interested in its progress and its beneficent contributions to humanity. But the Holy Father too realizes that science is no cure-all for everything, and much less a positive font of religious dogma, which latter even some outstanding scientists would seem to hold. With Pius XI of blessed memory he could say, as he did when representing him at the Pontifical Academy of Sciences that

> its [science's] mission appeared to him [Pius XI] to come in all its effulgence out of the same divine source whence pour out and descend to man the potent streams of the natural and rational sciences and the great river of revealed wisdom. Notwithstanding that the latter comes forth from deeper waters inaccessible to reason but not to Faith. . . yet [it is] not less certain and true.

Finally, Pope Pius XII realizes that even the good things can be abused and thus he would warn us never to use science in such a way as to forget our eternal destiny.

St. Mary's College,
St. Mary's, Kansas.

## SCIENCE AND PHILOSOPHY

REV. JOSEPH P. KELLY, S.J.

The following articles, dealing with problems in Science and Philosophy, have been published in the Bulletin of the American Association of Jesuit Scientists. (Eastern Section). (1933-1939)

### I. GENERAL RELATIONS OF SCIENCE AND PHILOSOPHY

Relations of Science and Philosophy. I. — Dec. 1934
by Joseph P. Kelly, S. J., Weston Col., Weston, Mass.

Relations of Science and Philosophy. II. — May 1935
by Joseph P. Kelly, S. J., Weston Col., Weston, Mass.

Scientific Questions Related to Philosophy — Mar. 1939
by John S. O'Conor, S.J., Woodstock Col., Woodstock, Md.

The Courses in "Quaestiones Scientificae". — Mar. 1937
by E. H. Larguier, S.J and
G. Tipton, S.J., St. Louis Univ., St. Louis, Mo.

Bibliography of Science and Philosophy. — Dec. 1934
by John S. O'Conor, S.J., Woodstock Col., Woodstock, Md.

Science, Metaphysics, and Human Knowledge. — Mar. 1938
by Joseph F. Beglan, S.J., Loyola Col., Balto., Md.

Some Limitations of Physical Science. — Oct. 1936
by Henry M. Brock, S.J., St. Robert's Hall, Pomfret, Conn.

The Philosophy of Mathematics. — May 1939
by Edward C. Phillips, S.J., Woodstock Col., Woodstock, Md.

The Philosophy of Measure. May 1937
by Antony J. Eiardi, S.J., Weston Col., Weston, Mass.
Scientific Definitions. May 1938
by Joseph P. Kelly, S.J., Weston Col., Weston, Mass.
Philosophy and Biology. Mar. 1939
by Joseph A. de Laburu, S.J., Gregorian Univ., Rome, Italy
Scholastic Vitalism. Dec. 1933
by Joseph C. Glose, S.J., Woodstock Col., Woodstock, Md.

## II. SPECIAL QUESTIONS

Mass and Matter. Mar. 1934
by John S. O'Conor, S.J., Woodstock Col., Woodstock, Md.
Matter and Form. Mar. 1935
by Antony C. Cotter, S.J., Weston Col., Weston, Mass.
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Statistical Laws and Causality. I. May 1934
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Nature's Laws and the Principle of Causality. Dec. 1935
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Statistical Laws and the Principle of Causality. II. Mar. 1936
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Francis W. Power, S. J. Pt. I Dec. 1936
Fordham Univ., Fordham, N. Y. Pt. II Mar. 1937
Pt. III May 1937
The Concept of Order. Mar. 1936
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The Concept of Space in Suarez and Einstein. May 1936
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Some Philosophical Aspects of Multi-dimensional Space (Abs.)
Oct. 1937
Robert B. MacDonnell, S.J., Weston Col., Weston, Mass.
Hamilton's Principle as a Physical Law. (abs) Oct. 1937
Joseph T. O'Callahan, S.J., Holy Cross Col., Worcester, Mass.
Essential and Accidental Differences.
J. Joseph Lynch, S.J., Fordham Univ., Fordham, N. Y. Mar. 1934
John J. Toohey, S.J., Georgetown Univ., Wash., D. C. May 1934
Joseph T. O'Callahan, S.J. Mar. 1935
Holy Cross Col., Worcester, Mass.
Indeterminism and Free Will. May 1939
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## III. VARIA



The Bulletin of the American Association of Jesuit Scientists, (Eastern Section), is published quarterly, under the direction of the Professors of Sciences in the Colleges and Universities of the Maryland-New York and New England Provinces. Editor, Rev. R. B. Schmitt, S.J., Loyola College, Baltimore, Md.

# CHEMISTRY

## AN IMPROVED METHOD FOR MOLECULAR WEIGHT DETERMINATIONS OF ORGANIC SUBSTANCES.

Rev. Richard B. Schmitt, S.J.

A molecule is composed of atoms; and the fundamental problem is the determination of the number of atoms which belong to each individual molecule. What means are at our disposal by which this number may be obtained, whether the substance be in the gaseous, liquid or solid state? In order to discuss this problem, it seems necessary to recall some fundamental ideas of molecular structure.

In a given molecule, at constant temperature, each atom must on the average, maintain the same position in space relative to the position of all the other atoms in the same molecule. The number of atoms which maintain the constancy of relative position are the number which compose the molecule. Hence it follows, that if one of the atoms of a molecule is displaced in space, all the other atoms in it must suffer a corresponding displacement, so as to maintain their relative positions unchanged.

Of course, the molecule as a whole may move about, or rotate, or vibrate. In the gaseous state the size of the molecule is expressed by the formula: $M = \frac{w\,R\,T}{P\,V}$ This size or "molecular weight", being referred to hydrogen as unity. From this molecular weight the number of atoms composing the molecule may be deduced. The size of the molecule is then based on the gas laws, and the molecule is to be regarded as the unit particle which registers a pressure by hitting the walls of a container. In a gas, the atoms of a molecule form a small cluster, which moves through space as a unit and is quite distinct from similar clusters.

When a gas is compressed, the molecules are brought closer and closer together and if the temperature is sufficiently low, the forces of molecular attraction cause liquifaction. In liquifaction the molecules are so close together, that specific atoms in one molecule begin to influence specific atoms in another. It is therefore more difficult to determine the exact size of the molecule in the liquid state.

As the temperature is lowered still further, the effect of the attractive forces become more marked, and finally solidification occurs as a result of the specific attraction of atoms in neighboring molecules for one another. Each molecule loses its individuality as it joins on to the crystal, since all the atoms of the solid are fixed in place and cannot be displaced relative to their neighbors. The whole crystal therefore, must be regarded as a single enormous molecule.

The molecular weight of a solid, strictly speaking, is merely the weight of the whole crystal divided by the weight of the hydrogen atom. The stoichiometric proportions of the various elements composing the solid are, of course, independent of the size of the crystal. In the case of a solid substance a formula is assigned which gives these stoichometric proportions. This is often the same as that which represents the molecule of the substance in the vapour state.

It is evident that the concept of the molecule is one of great simplicity in the gaseous state. It is virtually meaningless in the solid state. However, in the liquid state complications may arise when association occurs, and the size of the molecule may vary with the pressure and temperature. This leads to great complications in the treatment of the physical properties of associated liquids as applied to molecular weight determinations.

*Determination of Molecular Weight by the rise in boiling point of solution.*

When determining the molecular weight of solute particles by the boiling point method, various factors influence this method; among these are diffusion, pressure due to the dissolved substance, concentration of solute and solvent, careful control of temperature, and the volume of the solution. In the liquid state, the pressure-volume-temperature relationships cannot be formulated with very great precision, on account of the large effects due to molecular attraction and to the volume of the molecules. We might also recall that the identity of size between structural formula and solute particle is by no means the general rule, and the attempt to find the size of the structural formula from molecular weight determinations in solution has often led to erroneous results, since the size of the solute particle, varies with the concentration of the solution.

Another fact to be considered in this boiling point method of molecular weight determinations is that a pure liquid at a certain temperature is in equilibrium with its own vapour. The faster moving molecules of the liquid are continually escaping and entering the vapour; molecules from the vapour are also continually returning and entering the liquid. At equilibrium, the number of molecules leaving is equal to the number returning, and there is a constant pressure in the vapour phase which is the vapour pressure of the liquid.

If we now add a non-volatile solute to the liquid, as we do in this experiment, there will be fewer molecules of solvent per unit volume than before. There will then be fewer molecules per unit volume which possess the energy necessary to enable them to escape from the liquid. The vapour pressure of the solution is then lower than the vapour pressure of the pure solvent. Now, since the boiling point of a solution is merely the temperature at which the vapour pressure is equal to one atmosphere, it follows that the boiling point of a solute in a solvent (i.e. the solution) will always be higher than that of the pure solvent. Since the density of a dilute solution differs only slightly from that of the solvent, the density of the solution is approximately equal to that of the solvent, and hence is constant for a given solvent.

Great care must be exercised in measuring the rise of temperature in the boiling point of solutions. If the thermometer is put in the vapour of the solution, and not in the liquid, there is always the possibility of superheating, and so this method is not accurate, and cannot be used in this determination. So in order to measure the boiling point of a solution, it is necessary to immerse the thermometer in the solution or immerse the bulb of the thermometer in a few mls of mercury in a cup and the bottom of which is surrounded with the boiling liquid, which is the method used in this our experiment. Even in this method great precautions are necessary in order to prevent the superheating of the liquid. This can be controlled by heating the liquid very slowly and gradually bringing it to the boiling point. Sintered glass in the bottom of the boiler will also help, because this provides a large number of points on which bubbles can form. The thermometer must be a Beckman-Pregl type on which 0.001°C can be read. The open end of the apparatus is provided with a reflux condenser to prevent the escape of the vapour.

This reflux condenser may be attached with a good ground-glass joint, or it may be attached permanently to the apparatus. The purpose of having the ground-glass joint for the reflux condenser, is to add powdered substances for molecular weights determinations that cannot be made in the pellet-form. Furthermore, this construction aids immensely in cleaning the apparatus in preparation for the next determination. If the substance of which the molecular weight is to be determined is in the form of large crystals or in the pellet-form, there is no need of the ground-glass joint for the reflux condenser.

Research laboratories and those teaching courses in Physical Chemistry will welcome an improved method of molecular weight determinations. The vapor pressure method of Victor Meyer is rather limited; the freezing point method requires a rather elaborate set-up of apparatus; the boiling point method is by far the simplest but still requires certain precautions which are necessary for correct results.

The boiling point method, using micro quantities, recalls the work of Pregl, Romer, Rieche, Swietoslawski, Suchard and Bobranski.

The apparatus of the boiling point method which we are discussing was originally designed by Swietoslawski and Romer; then modifications were made by Suchard and Bobranski. We made a change in this apparatus which facilitates the adding of the sample to the boiling liquid or solvent, and also helps in thoroughly cleaning the apparatus for the next determination.

*Description of the Apparatus*

The essential features are: the boiler, the undulating tube, the cups (inner and outer), the condenser and syphon tube. The ground glass joint at the lower end of the condenser is for the easy insertion of the sample.

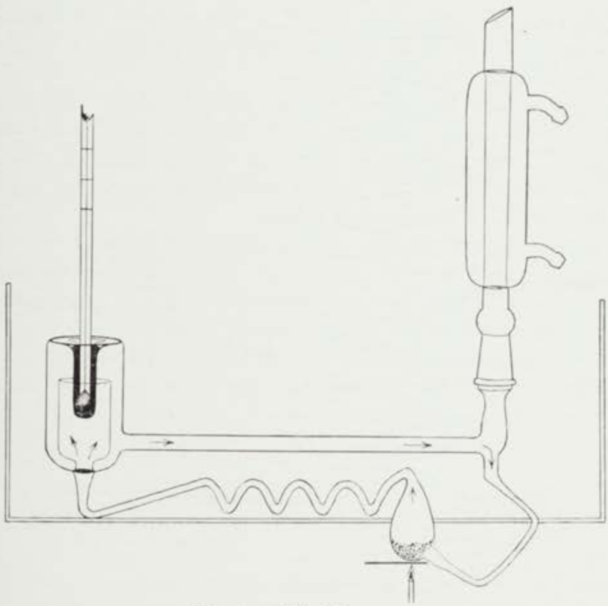


Fig.1. Ebullioscope.

About 5 ml of solvent are necessary for one determination. About 3 to 4 ml of mercury are required to surround the mercury bulb of the Pregl-Beckmann thermometer, which is inserted in the outer cup and held by a clamp. Under the boiler there should be an asbestos wire gauze and a micro burner provided with a chimney. In the lower portion of the boiler is powdered glass. An asbestos board is fitted underneath the apparatus. When solvents of low boiling points are used, e.g. acetone, it is necessary to surround the entire apparatus with asbestos board.

All these precautions are necessary to regulate the heat for the constant temperature of the boiling liquid and to avoid super-heating of the solvent. The flame of the burner is regulated so that the liquid gently overflows the rim cf the innner cup. Occasionally it may be necessary to heat the outside of the cup with a small flame of a Bunsen burner, when a large amount of solvent accumulates at the bottom of the cup and prevents circulation of the liquid. This may happen at the beginning of the experiment. When the regular circulation of the liquid is in progress, after five to seven minutes, the temperature readings should not vary more than .002 degree C.

After recording the boiling point of the solvent to the thousandth part of a degree, the micro burner is removed for two minutes, and the sample is added to the solvent. If the sample is added in the form of pellets, it may be added through the condenser; however, if the sample is in the form of small crystals or powder, the condenser is removed until the sample is added to the solvent. Some materials cannot be put in the form of pellets, therefore we made a ground glass joint at the base of the condenser.

Now the micro burner is again placed under the boiler, the sample dissolved in the solvent, and *continuously* heated until the boiling liquid freely circulates through the apparatus. In 3 to 5 minutes the elevation of the boiling solvent is carefully read to the thousandth part of a degree and noted.

The entire apparatus should be properly shielded from drafts or currents of air. This is most important, and if this precaution is not observed accurate results are not obtained. This is particularly true when the solvent has a low boiling point; with benzene and solvents of higher boiling points there is less danger of inaccuracy.

The weighing of the solvent is done in a specially constructed pipette, which holds approximately 5 ml. Cf. diagram.

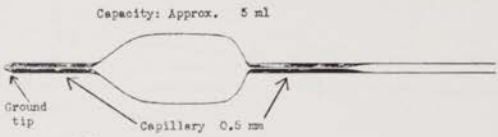



Figure 2. Pipette for Solvent

The amount of sample used should be about 18 mgs. Both the solvent and the sample may be weighed on a good macro balance. All the determinations we made, were done on an ordinary Ainsworth macro balance.

The formula for calculations:

$$\text{Mol. Wt.} = \frac{C \times \text{Wt } s}{\text{Wt } S \times \Delta}$$

C Constant of solvent i.e. benzene
s sample
S Solvent
$\Delta$ observed elevation of boiling point.

or log C i.e. benzene
plus log Wt sample
plus neg log Wt Solvent
plus neg log obs. elev. boiling point
anti log of total is Mol. Wt.

*Directions for Ebullioscopic Method for Molecular Weight Determinations.*

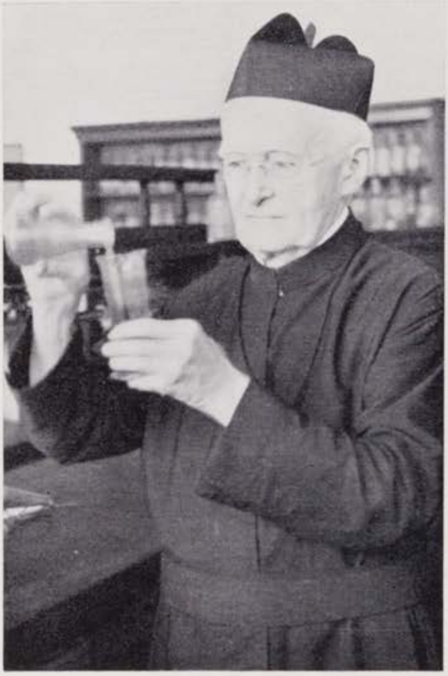
1) Adjust Beckmann-Pregl thermometer in a small amount of mercury surrounding bulb of the thermometer.
2) Fill 5 ml pipette with solvent, e.g. benzene. (Fill pipette from capillary to capillary.)
3) Weigh pipette and Solvent.
4) Put solvent in apparatus. Adjust the ground glass connection; and allow water to run through condenser.
5) Weigh empty pipette.
6) Make pelettes of material of which Mol. Wt. is to be determined.
7) Weigh pelettes in weighing tube. About 15 to 20 mgs.
8) Start heating the solvent with micro burner. If necessary, wave a small Bunsen flame at the base of thermometer, in order to get complete circulation of boiling solvent.
9) In about five minutes, read the constant temperature of the boiling liquid; read to the thousandth part of a degree.
10) Take micro burner away from boiler.
11) Put the sample into the solvent.
12) Return micro burner to proper place under boiler.
13) In 3 to 5 mins. note the rise in temperature or the elevation of the boiling point. Be sure the temp is constant.
14) Weigh empty tube that held the pellets.
15) Calculate.

| | | |
|---|---|---|
| Log constant, e.g. benzene | 40993 | |
| plus log Wt. sample | 20710 | |
| plus neg log Wt. Solvent | 36281 | |
| plus neg log obs. elev. bp | 12494 | |
| anti log | 1.10478 | 127.3 Mol. Wt. |
| | | Theor. 128.2 Mol. Wt. |

MOLECULAR WEIGHT DETERMINATIONS
by Ebullioscopic Method

| SUBSTANCE | Sample g | Solvent g | Elev. bp C° | Mol. Wt. Found | Mol. Wt. Calculated |
|---|---|---|---|---|---|
| | Solvent: Benzene (K=26.7) | | | | |
| Naphthalene | .0161 | 4.337 | .075 | 127.3 | 128.1 |
| Naphthalene | .0154 | 4.329 | .055 | 132.2 | 128.1 |
| Resorcinol | .0176 | 4.323 | .092 | 113.9 | 110.1 |
| Camphor | .0225 | 4.332 | .090 | 148.7 | 152.2 |
| Di-guaiacol p—methyl cyclo hexane | .0231 | 4.328 | .039 | 352.7 | 342.4 |
| | Solvent: Acetone (K = 17.2) | | | | |
| Vanillin | .01701 | 3.862 | .050 | 152.5 | 152.4 |
| Vanillin | .02108 | 3.870 | .043 | 149.6 | 152.4 |
| tert. octyl phenol | .01903 | 3.856 | .063 | 210.3 | 206.1 |

# Our Jubilarian



**Reverend John A. Brosnan, S.J.**
**Professor of Chemistry**

On October 12, Woodstock College celebrated Father Brosnan's triple jubilee: sixty years a Jesuit, fifty years a priest, and fifty years at Woodstock College.

Father Brosnan studied chemistry at Harvard, and at Johns Hopkins University under Ira Remsen.

Almost his entire life he was Professor of chemistry, and at various times he taught other divisions of natural science: physics, experimental psychology, biology, geology, mathematics and astronomy. There are few Jesuits in the province who have not at some time been students of Father Brosnan, and his influence on science in the provinces of Maryland—New York and New England would be difficult to estimate.

He is well known to our *Bulletin* readers for many splendid articles on photography, a lifelong scientific hobby which he raised to an art.

A. M. D. G.

# MATHEMATICS

## SQUARING FOUR POINTS

### A School Exercise and a Mathematical Recreation

REV. EDWARD C. PHILLIPS, S.J.

Part I—Bulletin, October 1939—page 26.

PART II

**Accommodation to the High School level**

When the analytical solution was presented to the proposer of the problem, it was conceded to be interesting; it might be excellent for college students, but for high school boys, who are ignorant of Analytical Geometry, it would be unintelligible. Could not the treatment be adapted to their condition?

Though no intuitive solution had rewarded our previous efforts, the experience gathered in developing the analytical solution supplied the desired key and the following solution involving only elementary notions supposed to be possessed by those who have made the ordinary high school course in Plane Geometry was found. It makes use of most of the principles underlying the analytical solution, but is more simple and direct and also easier of application.

Let A, B, C, D in Fig. 5 be the four given points, paired off in the order AC;BD. Then proceed as follows:

1. Join B and D by a straight line.
2. Through A draw a perpendicular to BD extended if necessary.
3. On this perpendicular lay off from A a segment AI equal to BD.
4. Draw a line through I and C; through A draw a parallel and through B and D draw perpendiculars to CI. And that's all.

Tre resulting *rectangle*, EGFH *is a square* whose sides pass one by one through the four given points. Q. E. I.

PROOF. From A and B drop the perpendiculars AL and BM to the opposite sides of the rectangle, thus forming the two right-angled triangles AKI and BLD.

By construction these two triangles have their three sides respectively perpendicular; therefore they are similar. Moreover, by construction, the hypotheneuses AI and BD are equal. Therefore the other homologous sides AK and BL are equal. But AK and BL are parallel respectively to the sides EG and EH of the rectangle,

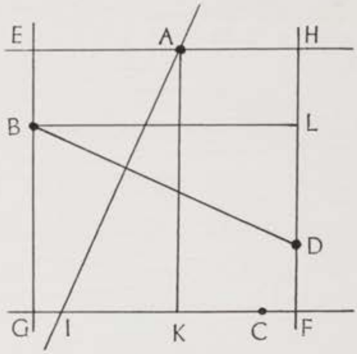


Fig. 5

and are included between parallels. Hence we have the following equalities:

| | | |
|---|---|---|
| EG=AK | AK=BL | BL=EH |
| Therefore | EG=EH | |

i.e. EGFH is a rectangle whose adjacent sides are equal; in other words *The rectangle* EGFH *is a square.*

Had we discovered this solution at the outset, we might have rested complacently in its possession as the full and satisfactory answer to the problem. But the analytical solution has taught us that there are in general *two squares* passing through the four paired points, and six in all if the ordering, or pairing, of the points is not determined beforehand. Hence we ask where is the second square for the paired points AC; BD? And in general how can we construct all the other squares on the four points?

### Completion Of The Graphical Solution

The answer to this question (which I must confess took more than a single look to discover) lies in the proper application of the third step prescribed in our construction: for we can lay off a segment equal to BD and starting at A *in two different, i.e. opposite, directions.* Hence we should complete the statement of steps 3 and 4 thus:

3. On this perpendicular lay off in both directions from the point A segments AI and AJ, each equal in length to BD.
4. Draw a line through I and C, and one through J and C; complete the rectangles of which IC and JC are each a side, by drawing the respective parallels through A and the respective perpendiculars through B and D.

The resulting rectangles EGFH *and* E'G'F'H' *are the two squares* passing through the paired points AC;BD. Q. E. I.

The proof is derived in the same way for both squares. We repeat the construction for the ordered points AB;CD and AD;BC and thus obtain *all six squares*. This however is fully realized only

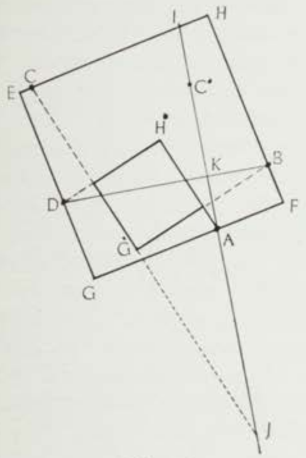



Fig. 6

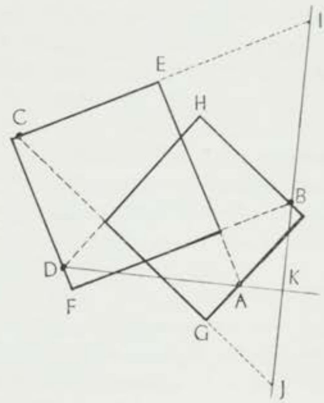



Fig. 7

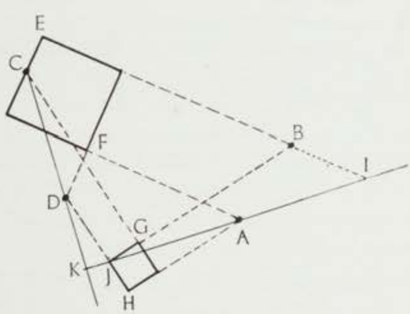



Fig. 8

in the ordinary or *regular case*, i.e. when there are no special relationships of the four points leading to singular or indeterminate solutions of the problem. (See Figures 6, 7 and 8).

These three figures give the complete set of six squares; the first gives the two squares on AC;BD; the second those on AB;CD, and the third on AD;BC. If these are traced on transparent paper and superposed one will have a picture of all six squares whose sides, *extended if necessary*, pass through the four points.

Let us now examine the purely geometic solution to see under what conditions there are exceptional cases and to what results these lead.

### Exceptional Cases In The Graphical Solution

The four points may be so related that when we make the construction indicated above we find that the line IAJ passes through the fourth point C. In that case (represented in Fig. 6 by the point C′) the line through I and C′, or through J and C′, will also pass through A; hence the parellel to JIC′ drawn through A will coincide with C′I and C′J, and consequently the two perpendiculars through B and D respectively will also coincide with each other; therefore the resulting rectangles both reduce to the same pair of perpendicular line-doublets, AC′ and BD, and we have the singular, degenerate case treated above in the analytical solution under Query b).

But suppose furthermore that having made the above construction and determined the point I, we find that not only does C lie in the line IAJ but actually coincides with the point I; then the direction of the line through C and I is indeterminate, since when two points coincide *every line* through one necessarily passes through "the other"; and therefore every rectangle constructed on the four points (paired in the order AC;BD) will be a square.* However we still have the point J, with which C cannot coincide as, by supposition at C lies on the opposite side of A at I. However the point C in that case lies on the line CJ and hence the square determined by means of the point J is a degenerate square or pair of line-doublets. We thus see confirmed our previous conclusion, from the analytical solution, that in the indeterminate case there is also contained, as a particular case, the singular or degenerate square.

The same argument holds when C happens to coincide with J (and hence not with I); then every rectangle through the four given paired points AC; BD is a square, and the one which is determined by the point I is the singular, degenerate case of this set. Since, moreover, the two segments AI and AJ are each equal to the segment BD and are in a line perpendicular to BD, we see that the indeterminate case occurs when the two segments AC and BD are mutually perpendicular and equal to each other.

This seems to be an equally full solution and examination of the problem, as the one secured by means of analytical geometry; it answers all the questions we proposed in the previous solution, and does so more directly and briefly. However, the analytical solution is by no means useless, because 1) it suggests to us the solution by plane geometry, and 2) without it, we might have overlooked some of the particular questions which we there proposed to ourselves and answered in a universal manner.

### Test Questions And Problems

We give here a list of questions and subsidiary problems of varying difficulty which may well test the completeness of the student's grasp of the general problem and also his ability to deduce certain

*Note that the PROOF that the construction outlined above gives *a square* is quite independent of the point C, and depends only on the four points AI;BD; any rectangle passing through these four points is *a square*, but only one of them is *the* square also passing through C.

properties or conclusions involved in or logically implied by what has already been proved above. It will also test his ability to discover the possibility of certain further exceptional cases depending on *abnormal* collocations of the original "four points": these abnormal collocations have been implicitly excluded throughout the entire development of the problems, because they would really reduce the four points to less than four by making two or more of them coincide. We will include some hints as a help towards the solution of some of the problems, and will also give some of the answers, without however, giving the details of their derivation or proof.

1. Can the two points I and J ever coincide?
   If you answer in the negative (normal cases), give the reason for your denial. If you answer in the affirmative (abnormal cases), explain the implication of your assertion.
2. Is it possible to have only one square when the indicated constructions give two distinct points for I and J?
3. When will all three of the equations (5a), (5b), (5c) have singular solutions? (For those who have not had the course in Analytical Geometry, the question should be worded thus: When will the six squares reduce to three pairs of perpendicular line-doublets?)
   Answer. When the four points are the vertices and orthocenter of a triangle.
4. When will the sides of one of the two squares on AC;BD be parallel to the sides of the other square?
   First Answer. When they are respectively perpendicular.
   Second Answer. When the segments AC and BD are equal to each other.
   Note. The first answer though paradoxical is true but insufficient, as it does not indicate what relationship between the four given points insures parallelism or perpendicularity of the two squares.

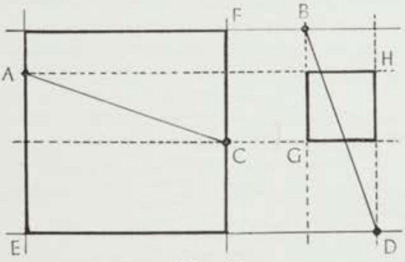



Fig. 9

5. When will the sides of one of the squares be equal in length to the sides of the other; i.e. when will the two squares be equal?
   Answer. When the segments AC and BD are parallel to each other.
6. How many pairs of mutually parallel squares are there in the indeterminate case?
7. Given one member of such a pair how would you determine or construct its parallel partner?

8. Are there pairs of equal squares included in the indeterminate case? If so, how many, and how can such pairs be constructed?

9. Prove that in the infinite set of squares belonging to an indeterminate case, the four vertices of all the squares lie on four circles, and that these four circles pass through one common point of intersection.

   Hint. Draw the two equal and perpendicular segments AC;BD and then draw the four circles indicated in the very beginning of this article. It is perhaps best to place the two segments so that they do not cut across each other.

10. It has been shown that any ordinary set of paired points AC;BD determine two and only two squares. Is the converse proposition true, namely that two intersecting squares determine two and only two pairs of points through which the four sides of the two squares pass? If not, state how many groups of paired points are common to the two squares and indicate what are the mutual relations of such groups.

11. If this way of proposing the problem proves to be too difficult for the tyro, he may be helped by being asked to prove the following assertions:

   a) Show that the sides of two squares intersect each other in 16 points.

   b) Show that these 16 points are the vertices of four parallelograms.

   c) Show that these 4 parallelograms fall into 2 pairs, the two members of any pair being equal in length.

   d) Show that the 8 diagonals of these parallelograms can be grouped into 4 pairs whose end points (A, C,; B, D, etc.), are ordinary four-points which fully determine the two original squares.

   e) Show that they may also be differently grouped into 4 pairs of equal and perpendicular segments, whose end points lie on the two squares but do not determine the squares.

   f) Show further that they can be still differently grouped in 16 ways so that their end points lie on both squares, and determine one of the squares but not both of them.

12. Using the appropriate propositions set forth in number 11, show that there is no contradiction between the answer to Question 5, which requires the segments AC;BD to be parallel for the case of two equal squares, and the presence of pairs of equal squares in the indeterminate case, i.e. when the two segments are perpendicular to each other, as implied or at least suggested in Question 8.

13. Can you suggest a construction for finding the rectangle passing through four given points AC;BD and having sides of a given ratio?

   Hint. Make use of the Lemma on which the analytical solution is based, and of Equations number (1) giving the segments cut off on the axes by a rectangle.

   If the student has not had Analytical Geometry, he should use the Lemma and adapt to it the construction by Plane Geometry given for finding the squares.

14. If the ratio of the longer side to the shorter side of the rectangle is $a/b$, show that there are two such rectangles for which the longer sides passes through A and C; and two others for which the longer side passes through B and D.

## "Squaring Four Points" As A Mathematical Recreation

We suppose two persons to engage in this geometrical game, and also that they are ignorant of the solution of the problem given above. Let one player mark the four points on a piece of paper, or on a slate or blackboard. The second player must then draw a rectangle on the four points, making it as nearly as he can a square. Measure two adjacent sides of the rectangle and take the ratio of the longer side to the shorter side; it is most probable that the ratio will not be exactly unity, and we will call it $1+e$.

The second player now marks down four points "to be squared" by the first player. Suppose the ratio of the sides of his rectangle is $1+f$.

The player who has the smaller remainder or excess over unity, wins the point for this trial. The play continues until one player has won e.g. 6 points out of ten; or five out of nine innings.

When the players are a little more experienced, the score may be kept differently: e.g. the winner is he for whom the *sum of the deviations* in five or ten plays is smaller than that of his adversary: thus a player who loses (in a set of five plays) four of the plays by a very small margin would win the game over an opponent who lost his one play by a bad rectangle for which the deviation from unity surpassed the sum of the other player's small losing deviations.

The next step would be to require each player *to pass two squares* through each set of four points:—Then they could be told to pass as many squares as possible through the four points. At this stage of the game it might be necessary to explain to the players that the four points can be taken in three different orders.

If the "recreation" is introduced as a diversion in a meeting of a Mathematical Club, the Director might take part in the first few games to start the members off on the right track (without revealing the key to the construction). To encourage his opponent he would do well in the first few plays to place his points very nearly at the ends of two equal and perpendicular segments, for in that case no matter what rectangle the boy draws it will almost surely be very nearly a square. Then he can give a few more difficult collocations, and withdraw from the game leaving the students to their own devices.

When the game has been understood, and especially if it "takes" well with the boys, it would be the right occasion to assign to one of the brighter members the task of treating the problem mathematically. The Director would doubtless have to help the boy in fulfilling this assignment, but that does not seem contrary to the end or methods of the Clubs, since the material presented in the meetings is for the most part not strictly "original"; it might even be a synopsis of some published article or book, etc. Some boys however, are very quick at solving problems, and the more they are left to their own ingenuity, within reasonable limits, the better.

Naturally, if any one uses the problem either as a recreation or as a program assignment, I would be interested in knowing the results obtained.

### Addenda

In answer to the request for information on any previous literature concerning this problem, Father Francis B. Dutram, of Boston College, called attention to the Problem Department of *School Science and Mathematics* for February, 1938, p. 222-223, where our question is briefly treated and the analytic solution for the slope of a side of a square on four given points is obtained in substantially the same form as that of equation (5) of this article. Likewise the coordinates of the four corners of the square and the formula giving the area of the square are obtained. The author makes mention only of the two squares whose sides pass through the four points in one given order. No graphical method of solution is indicated.

Mr. Charles E. McCauley, of Woodstock College, supplied a reference to the analogous problem of finding the squares inscribed in a given quadrilateral, which is proposed in the Problem Department of the May, 1939, issue of *The American Mathematical Monthly*.

Finally by a mere accident a rather rich bibliography of the two associated problems was found in the same publication, *The American Mathematical Monthly* for April, 1921 (Vol. 28, p. 185). I have looked up most of these sources and give a brief indication of their content; it would seem that many of those who treated the problem were either totally or partially ignorant of previous work done on it. I give the references chronologically, as far as the publications at my disposal allow. It may be well to note that our problem (a square on four points) is almost always referred to as the problem of circumscribing a square about a quadrilateral, corresponding to the terminology for the associated problem of inscribing a square in a quadrilateral.

1. (1803). L. N. M. Carnot: Géométrie de Position, Paris; 1803; p. 374-377. An analytic solution of the problem of inscribing a square in a quadrilateral; he notes that there are three solutions and seems to have missed the other three.

2. (1818). Lamé; Examen des différentes Méthodes employées pour resoudre les Problèmes de Géométrie; Paris, 1818; p. 16-17.—About a given quadrilateral describe another quadrilateral similar to a third quadrilateral. He finds 8 solutions: there should be twelve. No copy of this work available.

3. (1828). W. A. Diesterweg; Geometriche Aufgaben nach der Methode der Griechen. Andere Sammlung; Elberfeld, 1828; p. 172-173. To circumscribe a square about a given quadrilateral. I was not able to find a copy of this work.

4. (1850). Thomas Clausen in the problem department of Archiv der Mathematik und Physik (often referred to as "Grunert's

Archiv"); Vol. 15; p. 238-239.—To construct a square whose sides pass through four given points: he found six solutions, and developed the same graphical method of construction as outlined in this article (p. 83-84).

5. (1855). M. J. Murent in Nouvelles Annales de Mathématiques; Vol. 14, p. 365 ff., treats the more general problem of finding the rectangles circumscribed about a given quadrilateral and similar to a given rectangle. He obtains the analytic expression for the slope of a side of the circumscribed rectangle referred to a side of the quadrilateral, but is directly interested only in finding the condition on the original quadrilateral which will allow an infinite number of rectangles of the given shape to be circumscribed. He also finds the locus of the centers of this family of circumscribed rectangles; this locus is the circle which has the segment joining the mid-points of the diagonals of the original quadrilateral as a diameter.

6. (1864). Clausen in the Bulletin de l'Academie des Sciences de Saint Petersburg, Vol. 7, cols. 177-181, treats the problem of inscribing a square in a quadrilateral and shows that this problem bears remarkable relationships to the other one treated by him in Grunert's Archiv (see No. 4 above); all the properties of the square on 4 points have dualistic counterparts in the squares inscribed in a 4-line. This dualism was suggested to me by Mr. McCauley as a probable relationship between the two problems. I hope it may be more fully discussed sometime in the BULLETIN.

7. (    ). Lehmus in the Journal fur reine und angewandte Mathematik ("Crelle's Journal"), Vol. 34 (*not* 35 as quoted in the Math. Monthly), p. 280-283, gives an analytic solution of the problem of constructing a square on four points; his results are the same as those developed in the first part of this article; he indicates the six solutions and the condition for an infinite number of solutions. There follows a neat graphical construction, using only two circles: this construction, being different from those indicated in this article is reproduced below in Figure 10.

8. (1913). I. Ghersi in his Matematica dilettevole e curiosa; Milan, 1913, p. 587, gives a figure showing the six solutions of our problem. I have not seen this work.

9. (1913). Prof. Emch in the American Journal of Mathematics; Vol. 35, p. 407-412, art.: "Some Properties of Closed Convex Curves in a Plane", gives an analytic proof that in any such plane curve at least one square can be inscribed.

10. (1914). C. M. Herbert in the Annals of Mathematics; Series II, Vol. 16, p. 38-42, starting from Emch's article, shows that one and *only one square* can be inscribed in an ordinary *convex* quadrilateral. In the same periodical, p. 61-71, in a second article, Herbert refers to Clausen's claim of dualistic relationship of the two problems, and claims that the dualism is apparent only.

11. (1920). In the Revista Mathematica Hispano-Americana, for Sept., 1920, 228-229, the problem of constructing a square, given its four intersections with a line in its plane, is solved: three solutions are indicated—there are however six as shown above.

12. (1921). "ARC" (Prof. Archibald?) in The Amer. Math. Monthly, Vol. 28, p. 185, gives the bibliography referred to at the beginning of this list of reference. As the problem of inscribing a square in a quadrilateral is proposed in the May issue of the current volume of the Monthly, it will be interesting to see if any reference will be made to Prof. Archibald's bibliography when the solution is given.

13. (1938). (Fr. Dutram's reference). School Science and Mathematics, Vol. , p. 222-223. Solution of the problem: Given four points in a plane to find the slope of the side of a square passing through the four points, and to determine the corners of the square and its area. This is the article mentioned in the first paragraph above.

14. (1939). (Mr. McCauley's reference). American Math. Monthly for May, 1939.

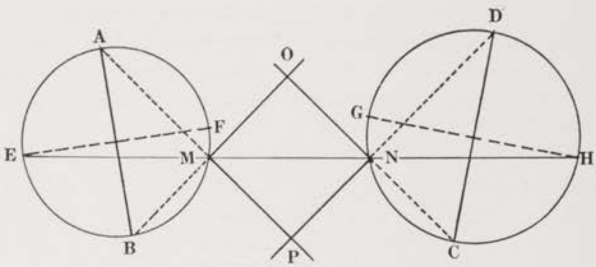



Fig. 10

Let A, B, C, D be the four given points. On AB and CD as diameters construct circles. Draw the diameter EF perpendicular to AB, and GH perpendicular to CD. Join E to H by a line cutting the two circles in M and N. Through M draw the chords to A and B; through N draw the chord to C and D. These two pairs of chords, extended if necessary, form a square passing through the four points. Note that the angles having vertices at M and N subtend arcs of $180^\circ$ and $90^\circ$; and hence LONP=LOMP=$90^\circ$, and LONM=LPNM=$45^\circ$. Therefore the quadrilateral MONP is a rectangle whose diagonal MN makes Ls of $45^\circ$ with the sides and hence is a square.

# GIROLAMO SACCHERI, S.J.
# AND
# EUCLID'S PARALLEL POSTULATE

Henry A. Boyle, S.J.

In these days when mathematicians generally are submitting the foundations of their science to critical investigation, and the Bulletin in particular has devoted some space in a recent issue to the relations of geometry to epistemology, the work of a remarkable Jesuit, who took the first steps in the new direction, deserve our attention and recognition.

Non-Euclidean geometry has its origin in the criticism of the Parallel postulate. In that century-old criticism a significant advance was made by an Italian Jesuit of Pavia named Saccheri

### I. Father Saccheri's Life

Giovanni Girolamo Saccheri[1] was born at San Remo in northern Italy on September 5, 1667, just as Louis XIV was coming to the full stride of his ambitious career. But the Duchy of Milan where Girolamo grew to manhood, under the protecting wing of the Austrian Emperor, Leopold I, was developing its cultural as well as economic resources and encouraging the foundation of schools. Thus when the young man was nine years of age, a course of philosophy was opened in his native San Remo and there his advanced studies were begun. His acute mind made rapid progress, such that the menologist tells us the master sent the other scholars to him with their difficulties.

The Society of Jesus, brought to Milan by Saint Charles Borromeo in 1571 and well known by this time throughout northern Italy, presented that attraction for the rapidly developing youth which is vocation, and in his eighteenth year he interrupted his studies to enter the Jesuit novitiate at Genoa. Four years later, in 1690, he passed from Genoa to the Collegio di Brera in Milan where he resumed his studies, at the same time conducting classes in grammar for the younger students. It was at the Brera under the advice of his professor, Father Tomasso Ceva, S.J., brother of the now famous Giovannia Ceva, that Saccheri took to studying Euclid's Elements. In 1693, with Father Ceva's encouragement, he wrote the "Quaesita Geometrica", the first fruits of his study.

Ordained priest in 1694, he was sent to the Jesuit College of Turin, there to teach philosophy and theology. Three years of lecturing in these most logical of Sciences produced the "Logica Demonstrativa", published without the young author's name. Transferred in 1697 to the College of Pavia, where again he lectured in

1. Account drawn chiefly from art. Saccheri, in *Encic. Ital.*, vol. XXX, Roma 1936; and from art. by Morrissey in *Thought*, Dec. 1937, vol. XII.

philosophy and theology, he found himself named by the Senate of Milan to the chair of Mathematics at the University. In 1701 the second edition of the "Logica" was issued, with no substantial changes, the author's name appearing confidently now after his longer teaching experience. In 1708 the "New Statics" came from his pen.

Father Saccheri remained at Pavia the rest of his sixty-six years, although Padua and Turin were making every effort to obtain his services. He continued his lectures in theology despite the professorship of Mathematics, and his pen was always active, editing his notes on theology when not engaged with the work of his predilection, Euclid. During all those years, his Jesuit companions tell us, he never lost his simple, unassuming ways, being one of those upon whom great talent and learning rest lightly. For all his modest manner, he was known and respected as a man of great virtue as well as learning.

In 1733 he published the "Euclides ab omni naevo vindicatus: sive conatus geometricus quo stabiliuntur prima ipsa universae Geometriae principia", embodying all the study and reflection since those first years under Father Ceva, checked and improved by the rigorous discipline of his work in philosophy, and now indicative of a great step forward in the analysis of the foundations of geometry. While at the Brera shortly after the work was published, Father Saccheri fell ill and after a brief five days of sickness he died on October 25, 1733.

The "Euclides vindicatus" for a long time drew no attention from the mathematical world. In that century of analytical geometry's first vogue, it is little likely that geometers were thinking along those lines. Rediscovered by Father Manganotti in 1889, the book's true character was made known to mathematicians through Beltrami, although as late as 1908 it was mistaken by at least one prominent mathematician[2] for no more than another edition of Euclid. The fame of the work spread through Europe and with time to America. Its recognition in our country is due to George Bruce Halstead whose special interest in non-Euclidean geometry led him to examine the "Euclides vindicatus" and eventually to publish it anew with translation.[3]

## II. Father Saccheri's Contribution

About 300 B. C. Euclid of Alexandria postulated "If two straight lines in a plane meet another straight line in the plane so that the sum of the interior angles on the same side of the latter straight line is less than two right angles, then the two straight lines will meet on that side of the latter straight line." Criticism of this postulate began in the very school where Euclid taught, lasted as long as interest in Mathematics lasted in the Graeco-Roman world,

2. By Heath, in his edition of Euclid.
3. Saccheri's Euclides vindicatus, ed. & trans. by G. B. Halsted, Open Court, Chicago, 1920.

passed with the Moslem conquest into the custody of the Arab scholars, was reopened in the West with the return of Euclid to the Schools, and has in the last hundred years yielded fruit worthy of so many centuries, the new Metageometry.

The theory of parallels as Euclid received it from the early geometers unconsciously presupposed the truth of the proposition enunciated above though believing it validly established. Euclid saw the logical error and sought to remedy it by constituting the proposition a postulate. Its claim to the rank of postulate, however, was questioned at once. Everyone admitted that there were first principles in all the sciences which being self-evident required no proof. The first four postulates were accepted as such. But the fifth postulate's claim to self-evidence was seriously doubted. Many were the the geometers who tried to establish that proposition either as a postulate or as a proven consequence of other truly evident truths, but none succeeded in commanding the evidence required. Many mathematicians of the present day, with a different concept of what a postulate is, with a different theory of knowledge, would have held such efforts futile. But in the naive epistemology of Euclid's day a certain conclusion was believed attainable, and so Poseidonius, Ptolemy, Proclus, Geminus, Simplicius and the Arab geometers sought by various methods to validate the proposition. And in more recent times Clavius, Cataldi, Borelli, and the Englishmen, Henry Savile and John Wallis took up the attempt.

At the end of two thousand years' discussion the conclusions reached might be summed up thus:

1. The truth of the Parallel postulate could not be discerned directly in the very concepts involved.
2. Nor could any other proposition enjoying such immediate evidence be found to take its place.

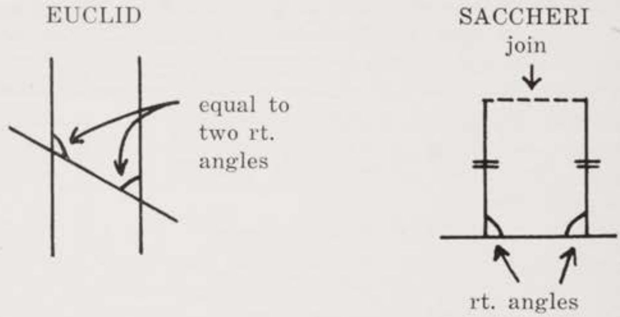
There came now a change of emphasis in the investigation. The object of the early geometers had been to establish the truth of the postulate so as to save the Euclidean system. Now the aim was veering more and more toward determining the logical dependence or independence of the fifth postulate with respect to the other four. Since, however, all efforts to prove it positively as a consequence of the other four had failed, it was becoming clear that a new method was needed. The filling of that need was the first of Father Saccheri's contributions.

If the fifth postulate could not be deduced from the first four by positive argumentation, the test for logical dependence must be made negatively. Saccheri would assume for his hypothesis the contradictory of that postulate while maintaining the others and develop the logical consequences. If he arrived at contradictions, then the dependence of the Parallel postulate upon the others would be established. But he envisioned a far more dazzling solution: from the denial of the postulate he would argue not to contradictions, but to the necessary truth of the postulate itself. This refinement was not a discovery all his own. It had been noted by Clavius in his commentary-edition of Euclid, the book Father Ceva had given him at the Brera; the writer of the Elements had used this procedure in Proposition XII of the IX Book. But Saccheri had developed this method to a perfection all his own. The application of it to the establishment of the fundamental propositions of a system was something new; Saccheri had done just that with it in his "Logica", and now he planned to do the same in his geometry. Vailati points out the passage in which Saccheri declares his mind on this matter. Explaining at the end of his first book the meticulous care he took to account for all the alternative hypotheses, Saccheri says:

> ". . . . one may inquire why I am so solicitous about proving the exact refutation of each false hypothesis. To the end, say I, that thence it may be more completely established that not without cause was that famous axiom assumed by Euclid as known in itself. For chiefly this seems to be, as it were, the character of every primal verity, that only by a certain recondite argumentation based upon its very contradictory assumed as true, can it be at length brought back to its own self. And I can avow that thus it has turned out happily for me right from my early youth in reference to the consideration of certain primal verities, as is known from my Logica demonstrativa."[4]

The deduction from the contradictory, then, was the weapon Saccheri had prepared for the attack; let us see to what effect he used it.

Instead of the two straight lines cut by a third so that the interior angles on the same side are equal to two right angles, as Euclid had it, Saccheri chooses an isosceles birectangular quadrilateral as being more convenient for his purpose. It is the special case of Euclid's general stipulation where the angles formed with the third line are specified to be right angles and the two lines are equal in length.




Given these conditions (in keeping with the first four postulates), he proceeds to show that the angles at the join of the extremeties of

4. Saccheri, *Euclides vind.*, p. 99; in Halstead's trans., p. 237.

the two will be equal to each other, and the possibilities with regard to the length of the join are three, depending upon the character of the angles. If the angles at the join be right angles, the join will be equal to the base, and Euclid's postulate readily follows. But if the angles be acute, or if they be obtuse (the double alternative, contradictory to the first possibility), the length of the join will be greater or less, respectively, than the base, and the contradictory of Euclid's postulate follows. There are three possibilities, therefore, which he calls the hypothesis of the right angle, the hypothesis of the acute angle and the hypothesis of the obtuse angle. From these hypotheses, in several preliminary propositions (theorems), he evolves an implication common to all alike: if one of these hypotheses is true in any one particular case, it alone is always true. Then, in Proposition XI he shows the consequence of Euclid's postulate from the hypothesis of the right angle. Next, he argues from the contradictory hypothesis of the obtuse angle, and in Proposition XII draws as a conclusion universally true, that two straight lines produced from less than two right angles, will meet at some finite distance on the side from which they are so produced: again Euclid's postulate! Then, as he quaintly puts it, "begins a lengthy battle against the hypothesis of the acute angle which alone disallows the truth of that axiom" (Euclid's postulate). This horn, indeed, proves more difficult. But he proceeds for that reason with still greater care and slower steps. In the midst of preparing the intermediate propositions that will supply his ground, he pauses to analyze, in the four long scholia after Proposition XXI, the solutions previously offered. First, Proclus' attempt is submitted to careful scrutiny. Again the "Logica" offers the instrument of discernment. The "complex definition", in which when one part is demonstrated the other is assumed to follow, is the hidden flaw detected here. Next, his respected predecessor, Borelli, is considered. Under examination his newly defined parallels appear to have acquired in a later postulate a few more properties than were assigned in the definition. Thirdly, the work of Nasiraddin and the plan of John Wallis are analyzed. These again contain the assumption of properties whose fitness to their proper subjects has not been shown. In the fourth Scholion, he undertakes to "explain a certain illustrative-figure which Euclid probably considered in order to establish his postulate as per se notum."[5]

From there he proceeds preparing the ground in succeeding theorems for the final exclusion of the hypothesis of the acute angle. In Proposition XXII, he concludes to the repugnance of this hypothesis with the nature of a straight line. But he wants to go on to that master achievement, the refutation of the hypothesis by itself. At last in Proposition XXVII, he deduces from the hypothesis the con-

5. Saccheri, *Euclides vind.*, p. 42; in Halstead's trans., p. 108.

clusion that a superscribed curve on the isosceles quadrilateral will be equal to the base, a situation inconsonant with Proposition III where it showed itself greater than the base. Hence in Proposition XXXVIII, "The hypothesis of the acute angle is absolutely false because it destroys itself." In this last hypothesis he has been cheated of the perfect victory, deduction from the contradictory; he must be content with reducing it to contradictions.

In Proposition XXXIX, finally, he arrives at the goal he had proposed to himself, the universal and absolute truth of Euclid's postulate. For he has accounted for each of the three hypotheses. The obtuse establishes the postulate, which then turns back and overthrows the hypothesis. The acute establishes certain conditions which are incompatible with its other consequences, and so destroys itself. The right angle hypothesis alone is left, by which the universal truth of the postulate is demonstrated, from which last the truth of the hypothesis itself is maintained.

The criticism of the work is yet young. Halstead, his most ardent admirer, has this to say:

> "Besides the Archimedes assumption, Euclid and everyone else for more than a century after Saccheri, assumes that the straight line is of infinite length. These assumptions nullify the possibility of a pair of obtuse angles in a birectangular isosceles quadrilateral, and to that extent prove the 'hypothesis' of the right angle, which is then equivalent to the Parallel postulate. But they are no obstacle to this pair of angles being acute.
>
> Had there been some other unconscious assumption of Euclid's, preventing their being acute, then Saccheri might well have declared the Parallel postulate completely demonstrated. But there is none."[6]

The argument up to and including the exclusion of the obtuse angle hypothesis is perfectly sound, so long as the Euclidean concept of a straight line is maintained, But the exclusion of the acute angle is not so certain, depending for its validity upon some unrecognized assumption in the physico-geometric demonstrations inserted in the third of those scholia on the solutions of the early geometers. It was by recognizing in their own way that this alternative was not excluded, that Lobatchevski and Bolyai in the succeeding century developed the first non-Euclidian geometry known as such.

Saccheri's work, then, was not flawless; but its contribution to synthetic geometry was of the highest value. The introduction of the negative test for the logical independence of a postulate has been absorbed into the fundamental laws of any postulate system. His warnings against incompatibility among the postulates and definitions, most detailed in his "Logica", are scrupulously heeded by mathematical logicians today. His analysis of the two alternative hypotheses, though both are ultimately excluded, was the first step

6. Halsted's introduction to his edition of *Euclides vind.*, p. xxix.

toward the complete recognition and acceptance of their possibility in a Metageometry. As for the obtuse angle hypothesis, it was left for Riemann in 1850, with a broader conception of the line, to explain its possibilities in the newest branch of Pangeometry, the elliptical geometry.

But the acute angle hypothesis, it is now known, involves no necessary contradictions, so that the fifth postulate is really independent of the other, and a complete logical system can be constructed out of them alone. In that event, up to the point where he discovers the contradiction, Saccheri is, whether he knows it or not, a non-Euclidian geometer. As Halstead says: "Since Euclid's assumptions, barring the Parallel postulate, are perfectly compatible with the hypothesis of the acute angle, many of Saccheri's proofs remain the most elegant and cogent the world possesses in the domain of non-Euclidean geometry."[7] "Saccheri was," then, in the words of J. W. Young, "the first to develop a body of theorems of non-Euclidean geometry, although apparently he did not know that he could not prove Euclid's fifth postulate."[8] His importance is summed up by Halstead: "How budded into the world the concepts which were to make of the Euclidean geometry, consecrated by the traditions of all ages, only a special case, a species of a genus, must be of eternal interest in this history of thought."[9]

7. Halsted's edit., *Euclides vind.*, p. 243.
8. *Fund. Concepts of Algebra and Geometry*, p. 29.
9. Halsted's edit., *Euclides vind.*, p. xxx.

# ASTRONOMY

## OCCULTATIONS AT JESUIT OBSERVATORIES

REV. THOMAS D. BARRY, S.J.

In Vol. VI., nos. 3 and 4, and Vol. VIII., no. 3 of the BULLETIN appeared articles on the reduction of occultations and on the progress which had been made in the work. It will be recalled that the moon, in its passage across the sky, passes in front of certain stars, the phenomenon being called an occultation. The observation of an occultation consists in noting by means of a chronograph or stopwatch the exact time at which the star disappears behind the moon. The reduction of an occultation consists in the numerical work of finding the error in the predicted position of the moon from the observed time. While at Georgetown this past summer I was curious to know just how much had been done by our observatories along this line. From the files of "The Astronomical Journal" and "Popular Astronomy" I compiled the following table showing the number of occultations published. An x after a number indicates that the observations were published without being reduced, that is, only the times were given. All the rest were reduced.

| Year | Georgetown | Zo-Se (Shanghai) | Weston |
|---|---|---|---|
| 1927 | 32 | | |
| 1928 | 34 | 24 x | 1 |
| 1929 | 16 | 83 x | 8 |
| 1930 | 74 | 40 x | 13 |
| 1931 | 75 | 28 x | 23 |
| 1932 | 20 x | 47 x | 23 |
| 1933 | 114 x | 35 | 7 |
| 1934 | 144 | 56 | 3 |
| 1935 | 29 | 35 | 7 |
| 1936 | 46 | 65 | 30 |
| 1937 | 23 | 31 | 9 |
| 1938 | 75 | 31 | 27 |
| Total | 682 | 475 | 151 |
| Total reduced | 548 | 253 | 151 |

Besides these, Creighton University in Omaha published 15 unreduced observations for 1928-1929 and Woodstock 7 reduced observations for 1938. So altogether our observatories accounted for 1330 observations, of which 959 were reduced before publication.

*Notes:—*

*Rev. Luis Rodés, S.J., Director of the Observatorio del Ebro, Tortosa, Spain, and Rev. W. O'Leary, S.J., Director of the Riverview Observatory, Sidney, Australia, died during the past summer.*

## METEOROLOGY

Rev. Charles E. Deppermann, Assistant Director of the Weather Bureau, Manila Central Observatory just published another volume for the Department of Agriculture and Commerce. This Volume is entitled: "Some Characteristics of Philippine Typhoons." In the introduction is an explanation of the scope of this work, a tribute to past workers and an historical retrospect.

Then follow seventeen chapters (136 pages) which include rather complete phases, conditions and characteristics of Philippine typhoons. Such topics as: The relative and absolute calms, anomalies between barometric gradient and wind force, barometric oscillations in typhoons, miscellaneous wind and rainfall data are carefully described with accurate measurements.

There are eight tables with complete data on other conditions that accompany typhoons; also miscelleanous maps and figures. At the end of the volume are ninety-three photographic reproductions of typhoon barograms with index.

We take this occasion to congratulate the author on this splendid research.

R.B.S.

# NEWS ITEMS

## WOODSTOCK COLLEGE

Recently Father Edward C. Phillips published a pamphlet entitled: "The Correspondence of Father Christopher Clavius, S.J., as Preserved in the Archives of the Pontifical Gregorian University."—Two-hundred and ninety-one letters are listed in chronological order from 1579 to 1608. Father Clavius taught mathematics for forty-seven years. "These forty-seven years were spent by Clavius in astronomical and mathematical pursuits during a period which was becoming more and more critical in the history of the natural sciences . . . . In this same period Galileo rose to fame both by means of his mathematical ability and his skillful development and use of the newly invented telescope, which enabled him to astonish the scientific world with a succession of wonderful discoveries concerning the appearance, motions and character of the heavenly bodies." There are many other interesting facts recorded in this volume.

## WESTON COLLEGE

In the Astronomical Journal, May 22, 1939 is an article: "Occultations of Stars by the Moon, Observed at Weston College during 1938," by Rev. Thomas D. Barry and James K. Connolly, S.J.

## BOSTON COLLEGE. Physics Department

The Civil Aeronautics Authority appointed Father Tobin as Director of the Civilian Pilot Training at Boston College. Thirty students from the upper classes have finished ten hours of ground school and will report next month to the aviation field for flight training.

The Fabry and Perot Etalon is being used to perform exact measurements of wave lengths by photographing interference fringes superimposed on the lines of a spectrum. Wave lengths are measured by comparison with the primary standard, the red cadmium line. Because of the great resolving power of the instrument the fine structure of spectrum lines can be determined. The splitting up of lines in a magnetic field are also easily measured.

There are six students preparing for their M. S. degree in Physics and nine students taking the graduate courses in Physics.

### Graduate School

The Mathematics Library is growing steadily. Among recent accessions there is one item of interest to Jesuit Mathematicians. We recently secured the five volume set OEUVRES DE FERMAT published by Gauthier-Villars, Paris. Vol. III is entitled: Traductions par M. Paul Tannery 1° Des Écrits Et Fragments Latins De Fermat; 2° De L'Inventum Novum De Jacques De Billy; 3° Du Commercium Epistolicum De Wallis. The sub-heading for the second of these items is entitled: Nouvelles Découvertes Dans La Science De L'Analyse Recusillies Par Le Révérend Père Jacques De Billy, Prêtre De La Sociéte de Jésus, Dans Les Diverses Lettres Qui Lui Ont Été Envoyées, A Différentes Époques, Par Monsieur Pierre De Fermat, Conseiller Au Parlement De Toulouse. This work, Doctrinae Analyticae Inventum Novum, according to Sommervogel's Bibliothèque de la Compagnie de Jésus, was originally published in Toulouse in 1670 in folio. This work is listed under no. 14 of de Billy's works in Sommervogel.

The mathematics Academy is flourishing under the direction of Father Dutram. This Academy is open to members of the Freshman and Sophomore classes. About twenty have signified their intention of joining the Academy this year. Meetings are held semi-monthly. A mimeographed paper called "The Ricci Mathematical Journal" is published by the Academy bi-monthly.

### Biology Department

The school year opened with 169 students in this department Of this number, about half have chosen Biology as their Elective; the others belong to the A.B. pre-Medical, or the B.S. in Biology groups. In the Extension School, two new Courses have been introduced in Physiology and in Hygiene. These are given at the Intown Division of the College, in addition to the regular Saturday morning classes at Chestnut Hill.

There are twenty-two B.C. men in the 1st year Class at Tufts Medical School, which is the largest representation there from any college. Very pleasant relations exist between Tufts and Boston, and our students have a highly satisfactory record in that institution. It is interesting to note that fewer students each year are selecting Dentistry as a profession, although it requires less difficulty in entering, less time for preparation, and smaller outlay financially. A number of those who will receive their M.D. next June have already applied for Army or Navy hospitals, which is a rather significant fact.

## LOYOLA COLLEGE, Baltimore, Md. Chemistry Department

At the annual convention of the American Chemical Society held in Boston, Mass., during the week of September 11th, Father Richard B. Schmitt presented a paper before the Microchemistry Section, on the topic: "An Improved Method of Molecular Weight Determinations of Organic Compounds." (Cf. this issue, page 76).

On Thursday October 26th, Father Schmitt gave a lecture to the local section of the International Science Academy, Chemistry Section. The subject: "Recent Advances in Micro Analysis."

The Loyola Chemists' Club began its eleventh year on October 17th. The speaker was Roy A. Mansfield of the Southern Oxygen Co. He presented an experimental lecture on the subject: "The Future Opportunities for the Chemist in the Welding Industry."

Dr. George L. Royer, Calco Chemical Co., Bound Brook, New Jersey, gave an illustrated lecture on November 14th to the members of the Loyola Chemists' Club on: "The Application of Micro Chemistry in the Dye Industry." The lecture was beautifully illustrated with movies and kodochromes in natural color.

### MANILA OBSERVATORY, Manila, P. I.

Fr. Doucette's monthly statement of typhoon activities in the Far East are always awaited with interest and faithfully published by the U. S. Weather Bureau in their publication "Monthly Weather Review." Recently he has added comments on the upper air streams in relation to typhoons from data obtained from our pilot balloon observations. Mr. Tannehill, Meteorologist in charge of the Marine Division of the U. S. Weather Bureau, writes:

> "Your remarks on the upper winds in connection with the May typhoon were published in their entirety in the Monthly Weather Review of that month, and your similar notations in the June report will go to the editor tomorrow. These data are certainly of interest and value."

### HOLY CROSS COLLEGE. Chemistry Department

A. C. S. Meeting, Boston. Mr. Baril, Professor of Organic Chemistry, read a paper on "The Splitting of Aliphatic Ethers with dry Hydrogen Bromide."

Glass-blowing Course. Enrollment about 50 students. The following notice outlines the course:

Theoretical: Lectures and Seminars. (Tuesdays, 4.30 P. M.)

- (1) Chemistry of glass (Lectures).
- (2) Historical (Papers by students).
- (3) Modern glass—industrial applications (Papers by students).

Practical: Demonstrations and Glass-practice. (Ad lib.)

- (1) Preparing glass for use before the blow-pipe.
- (2) Cutting glass.
- (3) Shaping glass:
  - (a) making of bends, bulbs, seals, etc.
  - (b) making of glass-shaping tools.

(4) Construction and repair of Laboratory Glassware.

(5) Stop-cock grinding. Ground joints.

(6) Demonstrations by visiting professional glass-blowers.

Advised for students majoring in Chemistry—or students who intend to do advanced work in science.

Director of Course: Fr. J. J. Sullivan, S.J.

Suggested Readings for Students of Chemistry. A revised list of popular books dealing with Chemistry and its back-ground has been made available for the coming year. A section of the main Library (Dinand Hall) has been set aside for this collection.

The program of the Chemistry Seminars was published for the year. The topics cover a wide field of chemistry: Thermodynamics, organic chemistry, reaction rates, colloid chemistry, physical chemistry analytical chemistry and advanced inorganic chemistry.

## ST. PETER'S COLLEGE. Chemistry Department

### June Graduates

One M. S., Chemistry, has obtained a position in the Research Laboratory of the Best Foods Co., Bayonne, N. J.

One B. S., Chemistry, has an assistantship in physical Chemistry at Columbia University.

One B. S., Chemistry, has an assistantship at Fordham University.

One graduate student assistant resigned before taking his Master's Degree to take a position in the research laboratory of the Pharma Chemical Co., Bayonne, N. J.

Two new, one semester courses have been introduced, in Gravimetric Analysis, and Semimicro Acid Analysis respectively, open to Junior and Senior, with an enrollment of 14 students. There are one hundred and eighty-four students enrolled in the chemistry department.

## EBRO OBSERVATORY. Tortosa, Spain

Various conflicting reports concerning the death of Father Louis Rodés, S.J., former Director of the Observatorio del Ebro, have been current. The readers of the *Bulletin* will therefore be pleased to have the following official account contained in substance in a circular letter addressed by the present Director, Father Antonio Romaña, S.J., to scientists and heads of institutions with whom Father Rodés had been associated during his long career.

"It has become our painful duty of giving notice to our dear friends and colleagues of the death of the Rev. Father Luis Rodés, S.J., who for nearly twenty years had been the Chief Director of this Observatory. He passed away on the 7th of June, 1939, at 57 years of age in the town of Bianaraix (Mallorca-Balearic Islands).

The excellent work achieved by Father Rodés, not only in his daily labour as the head of the Observatory, but also in contributing efficaciously to so many International Congresses and by taking an active part in both national and foreign scientific Associations is well known to all; the high esteem that he enjoyed, is well proved by the great number of Institutions of all countries, who had offered him a seat of honour amongst their members.

For several years past he was suffering from arterial hypertension which latterly became worse on account of the moral suffering due to the difficult circumstances in which he had to discharge his duties. But above all the destruction by the Reds, (on the 12th of April, 1938, seven days before the fall of Roquetas into the hands of the nationalists), of the work of his whole life, depressed him so that he repeatedly entreated his Superiors the favour of being relieved of the post he was holding.

This was granted to him and when all seemed to indicate that after a long repose he would be able once more to resume his scientific researches, a blood vessel broke putting an end to his life. Surely the Creator, whose wonders had been so highly praised and described by Father Rodés in his masterly work **El Firmamento**, has called him to partake of His Glory, opening to him forever the treasures of His Infinite Wisdom."

### FORDHAM UNIVERSITY. Biology Department

Dr. John McAlister Kater, formerly of Detroit University, is now a member of the Graduate Faculty, as Professor of Physiology.

A new laboratory, operating room and lecture room were added to the department in Larkin Hall.

The following new courses are now offered for the first time: Experimental Vertebrate Physiology; Histology and Physiology of the Nervous System and the Special Sense Organs; and Histology and Physiology of the Endocrine Glands.

### WESTON COLLEGE. Seismological Observatory

Father Linehan and Father T. Smith conducted a Seismological Survey in New Hampshire last summer with the new portable equipment loaned by the Humble Oil Company of Texas. This survey was conducted in conjunction with Harvard University. Details of the trip and the equipment will appear in the regular pages of the bulletin in the near future.

Father Linehan is making his tertianship at Pomfret this year and the work of the station is being carried on in his absence by Father Smith, Mr. Devlin and Mr. Langguth.

The station came into considerable prominence lately with the local publicity on the quake of October 19th with an epicenter at the mouth of the Saquenay River in Canada. The quake was felt throughout New England.

### Astronomical Observatory

In the Astronomical Journal, May 22, 1939, is an article: Occultations of Stars by the Moon, Observed at Weston College during 1939. By Rev. Thomas D. Barry and James K. Connolly, S.J.

### Physics Department

After many successful years as head of the Physics department Father Brock has left Weston to take up his duties as Rector of St. Roberts Hall, Pomfret Centre, Conn. Father T. Smith has taken over this department in addition to his studies at Mass. Institute of Technology.

Father Quigley comes from Holy Cross each Sunday morning to conduct a course in advanced theoretical physics for the Theologians. It has proved very popular with ten Theologians in attendance each week.

## MATHEMATICS SOMETIMES PAYS—

The U. S. Civil Service Commission recently sent out a communication to various Observatories requesting their cooperation in the "Selection of Head Scientist-Astronomer to be Director, Nautical Almanac. . . . Naval Observatory, Navy Department, Washington, D. C."

For this service—i. e. directing the Nautical Almanac Office—the offered salary is $6,500 a year; certainly a very good allowance to start on. However, the *Government* (as really distinct from politicians) doesn't offer anything for nothing, and so the hopeful candidate for this position and this salary must have a very good equipment in native ability and in formal education before applying with any chance of success. The chief scientific requirements are:

1) A Ph.D. or equivalent degree, from an institution of recognized standing, based on major study in astronomy and mathematics (chiefly mathematics and gravitation astronomy, which is almost exclusively mathematics).

2) Seven years of progressive experience, including especially celestial mechanics, orbit work, fundamental positions and constants, computations, making and reducing observations, and use of astronomical tables. This experience must give definite evidence of the ability to perform the most difficult mathematical computations and derivations of values of fundamental astronomical elements and to conduct and supervise basic research and developmental work in theoretical astronomy. It should also have demonstrated administrative ability including an aptitude for training and developing scientists.

As this position is a Civil Service position, the Commission has to conduct the qualifying Examination—and we might be tempted to ask how many of the *Civil Service Examiners* are capable either of preparing and rating such an examination, or even of understanding what it is all about. The Civil Service Commission, thought of that too; so in their announcement they inserted the following paragraph:

> "In view of the importance of this position, the qualifications of the candidates will be passed upon by a special board of examiners composed of Dr. James Robertson, retired, formerly Head of the Nautical Almanac Office; Dr. Dirk Brouwer of Yale University; Dr. H. R. Morgan, Principal Astronomer, Naval Observatory; and Mr. A. W. Volkmer, Examiner of the U. S. Civil Service Commission. For the purpose of this examination the persons named will be examiners of the U. S. Civil Service Commission."

We may add that Dr. Robertson is an honorary Doctor of Science of Georgetown University.

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# NOTICE

## FIFTH ANNUAL MEETING

OF THE

# NATIONAL ASSOCIATION

OF

# JESUIT SCIENTISTS

### THURSDAY, DECEMBER 28, 1939

AT 7:30 P. M.

KNIGHTS OF COLUMBUS CLUB

STATE & SIXTH STS. COLUMBUS, OHIO

DISCUSSION: THE QUADRICENTENNIAL CELEBRATION

THE KNIGHTS OF COLUMBUS CLUB HAS TWENTY ROOMS AVAILABLE AT REASONABLE RATES.

E. D. SULLIVAN, MGR.

OTHER ACCOMMODATIONS AT THE NEIL HOUSE, A FEW MINUTES WALK FROM THE K. OF C. CLUB; ALSO REASONABLE RATES.

THOMAS SABREY, MGR.

### AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE CONVENTION

DECEMBER 26 TO 31, 1939