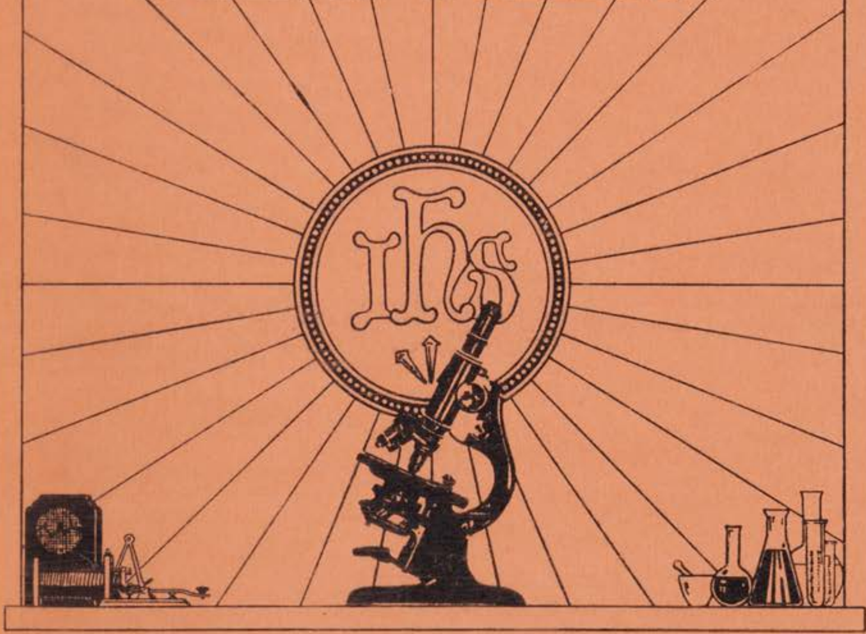
THE JESUIT SCIENCE BULLETIN



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NOTICE TO AUTHORS

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

THE MANILA OBSERVATORY RISES AGAIN†

CHARLES E. DEPPERMANN, S.J.

On the 10th of February 1945 the Manila Observatory died in terrible agony. After viewing its mangled corpse, Father Miguel Selga, S.J., its venerable Director, wrote the following touching epitaph:

> When I was a boy, at times in our class of humanities, I used to recite with some emotion, the ode composed by Rodrigo Caro on the ruins of Italy:
>
> Estos, Fabio, ¡ay dolor! que ves ahora
> Campos de soledad, mustio collado,
> Fueron un tiempo Itálica famosa.*
>
> Similar sentiments, but wrung from the depths of my soul, struck at my heart on March 7, 1945, while I contemplated with eyes filled with tears, the ruins of the Manila Observatory, and tried to distinguish among the heaps of debris . . . piled high upon this center of learning—the meteorological tower, the star-transit pavilion, the astronomical dome, the room for time-signal transmission, the seismological vault, the scientific library, the rooms of men dedicated exclusively to the progress of international culture—paraphrasing Caro, these lines came to my mind:
>
> Estos, alma, ¡ay dolor! que ves ahora
> Campos de soledad, montón de escombros,
> Fueron un tiempo cúpula famosa.

HISTORY OF THE OBSERVATORY

Just eighty years before, the Observatory had begun very humbly with the typhoon and climatological observations of two young Jesuit professors in the Ateneo Municipal in Intramuros, Francisco Colina and Jaime Nonell, aided the next year by Federico Faura, all still in their studies and not yet priests. Slowly but surely the work grew until Father Faura in 1879 had courage to issue public typhoon warnings. These warnings, together with the attention which the earthquake of 1880 focused on the Observatory, gave rise to such strong popular acclaim of this new "public utility", that a royal decree was issued on April 26, 1884, establishing a Government Weather Bureau, with the Jesuit Fathers of the Manila Observatory at its head. At first

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† Reprinted from *Philippine Studies*.

* "These fields, alas! of solitude you see, O Fabius, now, this hill of melancholy, were once upon a time famed Italy." Father Selga has paraphrased: "These fields of solitude, alas! my soul, you see, this mound of rubbish, once upon a time a famed observatory." *Editor's note.*

the principal station in Manila was supplemented only by stations in Luzon, but by the time the United States in 1898 was warring with Spain, meteorological substations had been established all over the Islands. In addition the Observatory conducted under governmental aegis, seismological, magnetic, and astronomical departments, the latter including the official time-service. After the Islands passed under United States control, the official status of the Manila Observatory, as the Weather Bureau or the Central Office of the Meteorological Service, was confirmed by law May 22, 1901. The service was thoroughly rehabilitated and augmented, with five Jesuit Fathers still in command under Father José Algué, as paid employees of the Government. This service, in all its departments, gradually expanded, but remained essentially as reconstructed in 1898, until the advent of World War II in 1941.

Destruction in World War II

The black pall of smoke enveloping the city of Manila on the first and second of January 1942 was but a figure of the pall that fell over the Observatory and its faithful service of over three-quarters of a century in the interests of humanity. The Fathers of the Observatory were held virtual prisoners in their offices, and Prof. Lachica, of the University of the Philippines, was placed in charge of what little meteorological work the Filipinos were permitted to do. The Japanese themselves, after vainly trying to divert the Observatory property to their own use and to persuade the Fathers to cooperate actively with Japan, established their own weather service in the engineering building of the University of the Philippines nearby. It is interesting to note that enemy efforts to carry off the Observatory instruments to other places were thwarted by a Japanese friend of one of the Fathers. He envisioned the Fathers as forecasting the weather for the whole of the "South Seas" if the Japanese won the war!

When the main building of the Ateneo was taken over by the Japanese in July 1943 as a military hospital, the equipment of the Observatory still remained intact in one win, under the nominal control of Prof. Lachica. So things stood until the siege of Manila brought final disaster in its train. In the last days of the siege, on February 9, 1945, the Japanese themselves were seen by reliable witnesses to set fire to and destroy utterly the astronomical building of the Observatory. It was obvious that they considered the apparatus therein as of strategic value. On the 14th of February incendiary bombs fell upon the east wing of the main Ateneo building, and in the flames perished the magnificent scientific 10,000 volume library of the Observatory, its offices and many other precious instruments and documents. The writer lost also manuscripts ready for printing or already printed but not distributed as yet, representing two or three years of work. Father

Selga was still more unfortunate; he lost historical research ready for printing, the painstaking labor of ten years!

Resurrection Starts

The terrible work of destruction was complete; the Observatory was to all appearances absolutely dead. But weather forecasting is of strategic importance, and it was not long before the first spasms of returning life began to appear. As early as August 1945, Rev. John F. Hurley, Superior of the Society of Jesus in the Philippines, wrote that Father Selga had already been approached three or four times by various sections of the American Army with reference to reconstruction. Furthermore, about the middle of July 1945 the Secretary of Agriculture of the Philippine Government announced to Father Selga his plan to have the latter organize the whole new meteorological set up and train personnel; then after two years he was to turn over the "machine" to the government. The scheme was entirely too vague, and hence the Society of Jesus was compelled to hold off from any decision. Next, around the first week of August, a practical-minded American Colonel proposed that the U.S. Army take complete charge of reorganization, bring in instruments, set up communications, train men, and, briefly, put into operation a first-class weather bureau. This was expected to take five years. He wanted to use the Jesuit Fathers in the reconstruction, and when the work was to be turned over finally to the Philippine Government, Jesuits were still to remain as a directive unit, as before the war. But, according to other information, it seems that the Philippine Government was desirous of a weather bureau run entirely by nationals, with the single exception that they were anxious to use Father Selga's vast experience for the reconstruction period only.

Thus matters stood until the passage of the Philippine Rehabilitation Act of 1946. The writer remembers, in early 1946, talking with Mr. Ralph Higgs of the U.S. Weather Bureau in Washington, who had drawn up a very ambitious reconstruction plan, to be financed by the U.S. Government. The details of the plan were discussed, but there seemed little likelihood that it could get through Congress without being brutally slashed. To the surprise of all, hardly anything was changed, and it was under this plan that the U.S. Government spent some five million pesos in reconstructing the Philippine Weather Bureau in all its branches on a scale far surpassing its former one. These funds were used also to send *pensionados* to the States to give them a thorough meteorological training. The Jesuit Observatory staff waited to see if they would be called upon to participate, but aided as they were by the splendid technical skill of American meteorologists, the Philippine Government considered that it was at last in a position to realize what all must admit was a very legitimate ambition: i.e. a weather bureau run entirely by Filipino scientists.

A Private Research Enterprise

Thus ended governmental connections with the Jesuits, and it was now for the Manila Observatory to decide whether it was to continue as an institution of scientific research or to rest content with the glory of its past. There was a certain amount of irony in the situation. The Manila Observatory had functioned for over half a century as a governmental agency, working for the *public* benefit, it had suffered much during the war because of its loyalty to the *public* interests of the Islands, its seismological and astronomical and meteorological instruments and extremely precious scientific library were deliberately destroyed because of their *strategic public* value, and yet the Observatory was forced, because of legal technicalities to seek compensation for its terrible losses by filing and proving its claim before the Philippine War Damage Commission like any ordinary *private* institution. As a result, only a very modest fraction of its total losses has been recovered. It was rather discouraging, and there were not lacking men who advocated that the Observatory be left to rest in peace! But, this was not the attitude of the Jesuit Superiors; they were of the decided opinion that the Observatory should rise again, even though it be at first along very simple and humble lines. After much thought it was considered best, because of the very limited funds available and for other prudential reasons, not to attempt weather forecasting in possible competition with the government, but to start with modest seismological research. For this reason, in 1947, the writer was sent to St. Louis University to brush up under Rev. James B. Macelwane, S.J., Director of Seismology, his all too meagre knowledge of seismology and to purchase the requisite instruments.

So early February of the year 1948 found the writer back in Manila with three Sprengnether seismographs and rather vague ideas as to where to locate them. But three days later an attack of peripheral neuritis, a consequence of beriberi contracted in the Los Baños internment camp, followed by pleurisy and severe asthma forced a reluctant postponement of all projects. Providentially, it would seem, for unnecessary duplication was thus avoided. The plan had been to set up the instruments somewhere in Manila, relying on a statement made by one of the American meteorologists reconstructing the Philippine Weather Bureau, that the latter would not engage in work similar to that contemplated by the Manila Observatory. Evidently the Director of the Government Weather Bureau was not apprised of this mutual understanding, for it was learned later, just in time, that the Director of the Government Weather Bureau was obtaining from the very same firm, seismographs practically identical to those procured by the Manila Observatory, and would set them up in Manila. It was this, together with data obtained relative to astronomical "seeing" in various parts of the Islands that finally resulted in the site at the top of Mirador, Baguio City, being chosen as the future home of the Observatory. Because the Manila Observatory had to wait for funds from the Philippine War Damage Commission, however, no active steps could be taken until May 1951. It was then, too, that Rev. James J. Hennessey, S.J., Rev. Bernard F. Doucette, S.J., and the writer were exclusively assigned to the Observatory, with a temporary home at Villa Santa Rosa, Quezon Hill, Baguio.

Seismology

Work on the seismic vault was started at the end of May 1951, but it was not until the following January that it was finished, and a start made in setting up the seismographs and auxiliary instruments. Then followed a tedious period of testing and adjusting the delicate instruments; but finally in July 1952, the Observatory commenced publishing its monthly list of recorded earthquakes. A surprising number of these quakes are local to the Islands. In the vault are three of the latest model Sprengnether seismographs recording photographically; i.e. one vertical component with period of two seconds, and two horizontal components, one of which, with period of 14 seconds, records the east-west earth motion, the other, with short period of 1½ seconds, records the north-south motion. These are supplemented by two visually recording seismographs of U.S. Coast and Geodetic Survey type, in which most of the amplification is obtained through photoelectric cells and radio tubes. Both record horizontal earth motion, one N-S of long period of 14 seconds, the other E-W of short period of 2 seconds. The visual recorders were first installed in the seismic vault, but with completion of the main Observatory building they are now placed just outside the offices. The recorders are provided with an alarm system so that, if any large quake occurs, the records can be immediately read, and a radiogram rushed to the U.S. Coast and Geodetic Survey in Washington. The Observatory thus becomes one of a network of seismic stations throughout the Pacific Ocean region giving the very prompt quake information necessary for timely warnings against threatening *tsunamis*, or tidal waves arising from marine quakes. The seismic vault is entirely underground and of excellent reinforced concrete construction, and it very satisfactorily performs the duoble function of providing bedrock foundation for the seismographs and of practically constant temperature, two important requisites to keep the delicate seismographs from tilting and otherwise changing their constants.

Ionosphere Research

In the latter part of May 1951, too, work was started on the construction of the ionosphere station. The ground at the foot of Mirador near the beginning of the shrine steps was levelled by a bulldozer and a short road made to meet the Dominican Road. By the end of August the small building intended to house the instruments was finished.

The history of the ionosphere research project is quite interesting. In 1946 the writer had met Mrs. Marcella Lindeman Phillips, an international authority on the ionosphere, and the wife of General Phillips, of the U.S. Air Force, himself an eminent scientist. She was then setting up an ionosphere station in Manila between Ft. McKinley and the airport. For various reasons this project had to be abandoned, and the only ionosphere research in the Islands was carried on spasmodically by the government Radio Control Board at Tolosa near Tacloban, with visually reading instruments only. This type of work, but with superior instruments, seemed quite attractive as a profitable and important research field for the Manila Observatory and hence as early as June 1950 the writer was in communication with Mrs. Phillips in Washington inquiring about the cost of automatically recording ionosphere equipment. A very favorable turn was given the project in a letter from Mr. McNish, formerly of the Bureau of Terrestrial Magnetism, in which he offered with the approval of the Advisory Board of the Central Radio Propagation Laboratory of the National Bureau of Standards in Washington (to which both Mrs. Phillips and Mr. McNish belonged), to "set us up in business." In other words, they wished to lend the Manila Observatory a thoroughly up-to-date model of automatic ionosphere recorder (their C-2 model) for "a dollar-a-year," with the sole proviso that they be furnished with the routine data they specified. This offer was accepted, but it was not until September 1951 that the apparatus arrived, in twenty-six boxes large and small. By the end of the month the apparatus had been provisionally installed in the station and an eighty-foot mast erected to hold the two "delta" antennae. Irritating delays, however, followed, and it was not until the end of February 1952 that a radio engineer of the Bureau of Standards came to Manila to adjust the apparatus and to set the station functioning in earnest.

Since this is a new field of research for the Observatory, a few words of explanation are needed. The principles governing the ionosphere recorder are basically the same as radar, only the latter uses much higher radio frequencies. The ionosphere comprises principally the electrically charged layers of the atmosphere about 100 and 200-300 kilometers above the earth's surface. It is these charged layers that reflect back high frequency (short wave) radio waves, and the varying heights and nature of the layers determine the day-to-day conditions of transmission and reception of radio waves. The apparatus sends short electro-magnetic impulses vertically upward, and automatically records on film the time taken for the reflection, if any, to come back to the sender. The power of this recorder can be gauged from the fact that in 15 seconds or less it can scan conditions and automatically record them over the range from one to twenty-five megacycles. The recorder contains at least one hundred radio tubes, but under the supervision of Father Hennessey and his assistant this temperamental machine (dubbed "Iona") is kept under control, and Father Hennessey is faithfully sending weekly and monthly the very valuable information promised to the Bureau of Standards.

Next in order came the erection of the Observatory building proper. The plans had long been drawn up, but unavoidable delays referring to the adjoining vacation Villa postponed the actual commencement of erection until May 5, 1952, when the contract was signed and the digging of footings started. Slowly, it seemed, the work dragged on, but really the progress was rapid, and the Observatory wing, on the west side of the top of Mirador, was blessed on November 13, 1952. On the following day the Observatory staff moved into its new home. On the first floor of this wing are: the Observatory reception room and museum, store rooms, record room, workshop, four offices for the four members of the Observatory staff and two rooms for visitors. The second floor contains a fine combination library and recreation room, kitchen, dining room, toilet and showers, four living rooms for the staff and one room for visitors. Last but not least is the really beautiful domestic Chapel of Our Lady of the Sacred Heart, designed by Bro. Bencze, S.J.

Astronomy Planned

The Observatory at the present date, August 1955, seems about to realize its fondest dreams, its completion as a well-equipped Observatory for solar research. We are just completing a contract with J. W. Fecker, Inc., Pittsburgh (at $54,000) for the construction of a combined spectrohelioscope and spectroheliograph, all-mirror type, which will be placed on the tower platform of the Observatory. We have already purchased the gratings for the instrument, two fine Bausch and Lomb precision replicas, 15,000 lines to the inch, one 8 inches long, the other 7 inches. With this powerful instrument, we shall be able to see the sun and study it, not only in the light of hydrogen alone and calcium, but in the light of many other elements hitherto untouched. With this instrument, it should be noted, we study the *causes* of the changes in the ionosphere, and hence it forms a well-knit whole with the work of Fr. Hennessey. It should also be noted that we shall have immediate access to the records in terrestrial magnetism and its changes obtained by the fine new magnetometers of the Philippine Coast and Geodetic Survey in Manila. Furthermore the Observatory gets its best weather during the Fall, Winter and Spring, i.e. at a time when most other solar observatories, except that of Kodaikanal, have their poorest weather. The Observatory will therefore fill an observational gap long deplored in the Pacific.

In great part, therefore, the Manila Observatory has already risen again from its ruins, and already is doing research work of admitted value. On April 27, 1951 Very Reverend Father John B. Janssens, General of the Society of Jesus, wrote to Rev. Leo A. Cullum, then Superior of the Philippine Mission, of the Society of Jesus, that he was very pleased to hear of the plan to maintain the Observatory's high reputation in science and even to increase this reputation.

With the funds in prospect the Observatory may, with the purchase and erection of our astronomical instruments, be able to increase its work and round out its plans for the resurrected Observatory. In any case it will continue the pursuit of fundamental scientific research for the benefit of humanity and the greater glory of God.

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ATHANASIUS KIRCHER, S.J.

A Contemporary of the "Sceptical Chymist"

CONOR REILLY, S.J.

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The birth of modern chemistry was a slow process and, though we give Robert Boyle the title of "father of modern chemistry," yet we do not claim that from the time he wrote his book "The Sceptical Chymist," science cast off its shackles of ignorance and superstition and began an unbroken course of development. Boyle's "fatherhood" was less a personal generation than a stimulus to others to bring to birth a new science. He pulled down and undermined old, unproductive ideas and theories, leaving space for the erection of the new. His "Sceptical Chymist" is, as its title claims, the treatise of a sceptic, pointing out the fallacies in the accepted doctrine, asking "why?" where others preferred to accept without question. It is the negative side of the book, not its positive, and, indeed, often unsound side that won for Boyle his title and set the chemists on the slow, erratic road to modern science.

In the year 1661 when Boyle wrote the book, there were many who practiced the art of "chymistry." There was no lack of experimenters, and experiments touched on all aspects of the subject in question. The experimenters were often men of brilliance, whose studies in other fields are still remarkable. But the chemistry of Boyle's day was based on false premises. What had been built so high could not be built any higher because the foundations were weak. Vague theories, insufficiently tried by experiment, were the basis of chemistry. In a fuddle of Aristotle's principles and qualities, which had been further complicated by the ignorance, and even by the willful obscurities of the alchemists, chemists of the day struggled along. They boiled, distilled, precipitated in experiment after experiment, but since the very fundamentals of their knowledge were incorrect, what real progress could they make? The practical arts of pottery and metallurgy could be advanced by purely empirical methods, but there was little hope of headway for the theorists, whose respect for tradition forbade them to question the wisdom of the ancients. This uncritical acceptance of the traditional notions was what Boyle had to combat. In freeing men's minds from these errors he permitted modern chemistry to come to birth.

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It was such a situation that Boyle had in mind when he wrote in the preface of his book (1):

> I observe that of late Chymistry begins, as indeed it deserves, to be cultivated by learned men who before despised it; and to be pretended to by many who never cultivated it, that they may not be thought ignorant of it: whence it comes to pass that divers chymical notions about matters philosophical are taken for granted and employed and so adopted by very eminent writers, both naturalists and physicians.

Not only did Boyle condemn this acceptance without criticism of the traditional doctrine, but he also condemned the willful obscurities of many "chymical writers" with their "obscure, ambiguous, and almost aenigmatical way of expressing what they intend to teach that they have no mind to be understood at all" (1). He ridicules their teaching that *ubi palam locuti sumus, ibi nihil diximus*—"where we have spoken clearly, there we have said nothing at all!"

Boyle was not the only "sceptical chymist" of his day, and the purpose of this article is to introduce a little known contemporary of the "father of modern chemistry" who had a similar critical approach to the science. This other was not as brilliant a man as was Boyle, though his learning was vast. He was a sceptic, though by no means as sceptical as was Boyle, and often he fell into those errors which Boyle warned others to avoid. Nevertheless, this man, Jesuit Athanasius Kircher, deserves recognition for his work, small though its importance may have been, which contributed to the birth of modern science.

Kircher's Genius

Athanasius Kircher was born on the second of May, 1601, in the little town of Geysa, near Fulda, in Germany. In his boyhood he showed no very obvious signs of the genius that was to mark his adult life, and it was only with difficulty that he gained admittance to the Jesuit novitiate at Paderborn in 1618.

Kircher completed his elementary studies in the Society of Jesus in Germany, and then, when driven from his fatherland by the Thirty Years War, he was called to Rome. There he was to take the chair of natural philosophy in the Roman College. He arrived in the city in the beginning of 1634, the year after the second trial and condemnation of Galileo. From then until his death, in 1680, he had his headquarters in Rome, where he studied, lectured, experimented, and wrote on the vast and general topics of the science of his day.

Kircher had arrived in Rome well equipped for his work. His languages included almost all the modern European tongues as well as the ancient languages of Latin, Greek, Hebrew, Syriac, and Coptic. He was a skilled experimenter and already had a book on magnetism to his credit, as well as another on Egyptian hieroglyphics. Moreover, he had interested himself in astronomy, a very topical subject just then. As early as 1625 he had observed sunspots through a primitive telescope and, in commenting on this astounding fact, had come to the revolutionary conclusion that the sun was made of the same materials as was our earth, and not of the unchanging quintessence of the ancients (2).

By the time he was 40 Kircher had studied and written on many other subjects. Several books on the ancient Egyptian obelisks, which had about that time been resurrected from the ruins of old Rome, appeared in those years. A mighty tome on music, "Musurgia Universalis," also belongs to this period, as do other writings on light, magnetism, certain mechanical devices, and even on ancient languages. Before his death Kircher had written more than 40 great tomes on scientific topics as well as a great number of smaller works and letters on similar matters.

This "universal genius," as he came to be known by his admirers, was a 40-year-old professor at the Roman College when the 12-year-old Robert Boyle visited the city, in 1641, in the company of his brother and their tutor. Boyle did not meet the Jesuit, nor did he visit the museum of natural history which Kircher was building up at the time. This was one of the first science museums in the world, and it lasted until the end of the last century when its contents were divided among the other museums of Rome. Later Boyle regretted very much that he had missed this chance of seeing the very ingenious water-organs and other musical instruments which had been invented by Kircher and were to be seen in the "Museo Kircheanum" (3).

On the outbreak of rebellion in Ireland, which caused serious financial embarrassment to his father the Earl of Cork, young Boyle was forced to retire, first to Geneva and then to England. He never again came to Italy. Thus, all further chances of meeting Kircher were lost (4).

Kircher continued to write and investigate while Boyle was beginning his scientific studies in England. Many of the Jesuit's books were published in Amsterdam, whence there was frequent traffic with England, and from the references in Boyle's books we can see that he obtained and read many of these works.

The minutes of a letter from Boyle to another Jesuit, Gaspar Schott, have been preserved. Schott was at the time professor of physics at Augsburg in Germany, and had been one of Kircher's friends and assistants. In the letter Boyle thanks the Jesuit for the present of a book and grants him permission to incorporate one of his own books into a treatise Schott intended to publish in the future. When Schott's treatise appeared some years later, Boyle's "Newmatical Book" appeared, along with one of Kircher's works, in the same volume. Thus was another link forged between Boyle and the Jesuit scientist at Rome (5).

A letter from Sir Robert Southwell, dated Rome, March 30, 1661, shows that Boyle had not lost interest in Kircher, but had sent him several inquiries through their mutual friend Southwell. "Father Kircher," writes Southwell, "is my particular friend and I visit him and his gallery frequently . . . all the questions you bid me ask him he affirmed to me in the same manner as you will find them written . . . ," (6). Kircher's "gallery" was his museum of natural history.

Southwell comments on Kircher's credulous nature, "apt to put in print any strange, if plausible, story that is brought to him," and without doubt, credulity is a feature of several of Kircher's books. Many of them were vast compendia of stories, descriptions, and observations, some of which must have made Boyle smile, as they did Southwell. Yet Boyle was acute enough to see the truth and the value of much of what Kircher wrote. Never one does he descend to abusing the Jesuit's uncritical approach to his subject. He never refers to Kircher but as "diligent," "learned," "inquisitive," "industrious," though he may sometimes disagree with his findings. Kircher himself did much to make amends for his too trusting acceptance of stories in several of his later books which even approach Boyle's standard in their criticism of traditional theories. However, as will be shown, he could never claim to rank as a sceptic beside Boyle, and at times would even fall under the general criticisms which Boyle made of the chemists of his day.

When, then, in 1661 Boyle published his epoch-making "Sceptical Chymist" he could have had Kircher in mind among the learned men, who had begun to "cultivate chymistry . . . the very eminent writers, both naturalists and physicians" who were taking so many notions about chemistry for granted. However, Kircher was certainly not one of those "chymists" who sought to hide their meaning under "an obscure, ambiguous, and almost aenigmatical way of expressing what they intended to teach." Willful obscurity was not one of Kircher's faults. Kircher, though, would appear to come under condemnation for "relating experiments by way of prescriptions, not of relations, for building up on experiments he himself had never tried, and of doing injustice to his own good name" by countenancing others' vague, unsatisfactory teachings (1).

It was possibly out of respect for such men as Kircher that Boyle, always a courteous and generous adversary, refrained from mentioning by name the writers he had in mind when he made such criticisms.

Boyle's book was soon translated into Latin, the international scientific language of the day, and it is likely that it came into Kircher's hand before long. Without difficulty the Jesuit would have been able to read between the lines and see there the criticisms of his own credulity. However, he was not inclined to abandon the traditional doctrine that salt, sulfur, and mercury were the true principles of things. It was on this doctrine that Boyle had made his major attack, though he affirmed that if the alchemists, or the "spagyrists" as he called them, would only prove their theories by sound experiments, he would be the first to return to their opinions. Boyle wrote:

> I have endeavoured to deliver matters of fact so faithfully that I may as well assist the less skilful readers to examine the chymical hypothesis, as provoke the spagyrical writers to illustrate it; which if they do, and that either the chymical opinion or the peripatetic, or any other theory of the elements differing from that I am most inclined to, shall be intelligibly explicated and duly proven to me; what I have hitherto discoursed will not hinder it from making a proselyte of a person that loves fluctuation of judgement little enough to be willing to be eased from it by anything but error.

Boyle was not wedded to his own opinion; he held his mind open for the truth.

"Mundus Subterraneus"

Kircher may have been answering this challenge when, in 1665, he published his most famous treatise, "Mundus Subterraneus." This vast work of 12 "books" in two separate volumes, was written in Latin. In it Kircher treats of everything that is to be found under the earth: of volcanoes, underground rivers and lakes, metals and metallurgy, underground animals and plants, and even underground men. The eleventh book treats of alchemy, a subject connected with the metals and minerals of the earth. Much of the treatise smacks of the over-credulous, but it is in keeping with the spirit of the times, and even Boyle would have passed over these doubtful matters and concentrated on what was of real value. Indeed, it is not hard to find rather similar descriptions of monsters and other incredible creatures in some of Boyle's works.

It is interesting to note that in the very year of its publication extracts from "Mundus Subterraneus" were published in the *Philosophical Transactions of the Royal Society* (7). Moreover, in the same year there is mention of the reservation for Boyle of a copy of the book at a London bookshop (8).

The book on alchemy carried the elaborate title of "Chymiotechnicus in Which All the Apparatus and Arts of the Chymical World are Described, Chymiotechnical Methods are Related to the Architype of Nature, and the Foundations of Pseudo-chemistry are Exploded" (9). The contents of this book must have interested Boyle intensely. In many particulars the work differs from Boyle's "Sceptical Chymist," though the general aim of the two books is the same. Kircher wrote:

> My intention has been to separate truth from falsehood, the licit from the illicit, the honest from the fraudulent . . . so that learned men, both physicians and philosophers, when they have examined these matters and experiments, may, along with me, be able to discern truth from falsehood (9).

Kircher's book undoubtedly contains many errors, and at times verges more than a little on the over-traditional approach to the subject. Yet, like Boyle's book, this work marks the end of a period—the period of superstition and obscurity in chemistry, though there is as yet but the faintest glimmer of the dawn of the new, fertile, critical period of the science.

We may neglect most of "Mundus Subterraneus" as not pertinent to our inquiry, and concentrate on the eleventh book, "De Alchemia." This is divided into two main parts; the first deals with alchemy in general, "De origine alchemiae" and the second is a critical study, leading to a rejection of the doctrine of the philosophers' stone. "De Lapide Philosophorum."

Kircher begins his investigation of alchemy by remarking that for many years he had been seeking information on this art. He questioned learned men in many lands; he read the books of Lully, Villanova, Roger Bacon, Paracelsus, Basil Valentius, and many other famous alchemists, but nowhere had he found what he sought. Finally, he had gone to the very sources of alchemy, to the Hebrew, Arabic, and Egyptian writings of Zohara, Zadith, Hermes, King Haled, and many others, and in the end of all this search he was forced to complain, like Boyle, of the obscurity and the enigmatical expressions of these men. Indeed, he says, "I came to the conclusion that nothing was easier than to write in such a way, putting down the first things that occurred to them, the most ridiculous phantasies of the human mind, in twisted words, solely to confuse whosoever tried to read them" (9).

He did, however, learn that alchemy was divided into three main divisions. The first is an honorable, well developed, and ancient science, *Alchemia metallurgia,* the science of metallurgy, which is also known as *Chymia.* This branch of alchemy deals with the methods of extracting, purifying, fusing, and preparing for use all types of metal. It is the source of all the alchemies, and is one of the most ancient arts known to men.

The second branch is far less honorable and less ancient than the others, and is called *Alchemia transmutatoria*. "It teaches," says Kircher, "the preparation and use of what medicine called the elixir which when thrown over a metal is said to perfect it in an instant, transforming the imperfect into the perfect, into gold and silver" (10). This is the branch of alchemy which deals with the philosophers' stone, and of that the writer will have more to say later on.

The third branch is known by many names. Some call it *Chymia spagyrica* or *analytica*. Others name it *Chemistria* or *Chymia medicinia*. It is the alchemy Boyle had in mind when he wrote his "Sceptical Chymist." This is the art of separating minerals and organic matter into their elements, essences, principles, and qualities, and applying these to the treatment of disease. It is a type of *materia medica* or *pharmacology*, an alchemy applied to medicine. This is indeed, adds Kircher, a praiseworthy study.

Kircher prefaces his more detailed descriptions of the techniques and instruments of the alchemists with words in keeping with what Boyle required of chemical writers. "All the experiments I am about to describe," he says, "were either performed before my eyes in the laboratory of the famous Roman College, or else were communicated to me by most reliable persons" (11).

Detailed and accurate descriptions of the furnaces used in the laboratories of the alchemists are not given, illustrated by excellent drawings and diagrams. Kircher describes the reverberatory, the calcinatory, the open, the closed, and many other types of furnace. The vessels used, the retorts, phials, and bottles, of clay, glass, and china are also described, and explanations of their various uses are given.

The following chapter, Kircher says, "is not just for the interest of the reader, but is to serve as a practical manual of techniques for the student." Here we find described methods of calcination and purification of metals, of precipitation, of sublimation, of solution, as well as what might be considered a very "modern" method of filtration. We are instructed to pour the suspension "through a filter, either of woolen or linen cloth, or through blotting paper folded or bent in the shape of a funnel; the residue will be left behind on the filter" (12).

The following chapters give prescriptions for various chemical preparations. We are told how to make various types of vitriol and other chemical substances. But for the archaic terminology used, the instructions might have been from an elementary text of today.

Kircher finishes this section by saying that "the above account of chemical preparations has been given to prepare the novice for further reading, by supplying him with sufficient chemical terms and methods" (13). He now feels that he can pass on to an elaborate examination of "The mystery of the Philosophers' Stone."

The Philosophers' stone, Kircher says (14), has been given many names: elixir, blessed earth, tincture, wood of life, etc.

> many of them ridiculous, others even blasphemous. The alchemists describe the stone as something wonderful and mysterious, which not alone can cure the human body of all ills and keep it healthy, but can also change base metals into gold and silver. . . . They say it is a pure, unchanging, most simple metallic substance, and that it is effective in infinitesimal amounts.

Far from believing such extravagant claims, Kircher bluntly states that most of what has been written about this "mystery" is a fraud and utterly useless.

There can be only one type of transmutation of metals, he continues, and this is to be learned from Nature, who "from the four elements generates the true principles, salt, sulphur and mercury, and from these, by correct proportions, produces trees, animals and all other material things" (15). Unless the alchemists imitate Nature and learn from her what is this "common matter" from which all other things are made, they will never make a success of their art of transmutation.

This reference to the "elements and principles" would seem to us to be in direct opposition to Boyle's teaching in the "Sceptical Chymist." However, it is well to recall a passage in that book in which Boyle suggests that "earth by a certain metalline, plastic principle latent in it, may be, in the process of time, changed into a metal. . . . It seems evident that water may be changed into all the other elements. . . . Animals and plants may be produced out of water" (16). Boyle, however, did not think that it was necessary to postulate any "common matter," "any primogenial and simple bodies, of which, as from pre-existing elements, nature is obliged to compound all the others." He felt that nature could bring about such transformations of elements by "variously altering and contriving their minute parts" (17).

Kircher maintained that the alchemists had long sought this true "prime material." At various times they have described it in various ways; have said it was a metal, a salt, or some other such substance; have held that it is to be found in hair, in rotten eggs, in human blood, in dung, or in some other outlandish place. Some of them have even given a prescription for its preparation from the four "elements," from air, fire, water, and earth, by separation, conjugation, putrefaction, coagulation, fermentation, and other meaningless processes.

He quotes Paracelsus who used mercury as the starting point for preparing the "prime matter of all metals." Paracelsus claims that by following his prescription it is possible to convert the "calx" of any metal into pure quicksilver, which is the starting point for all other metallic transmutations. "Well spoken, indeed," says Kircher, "but when this theory is examined rightly, it is seen that it does not answer to practice . . . for I say that all you have at the end is the same mercury with which you began, a little purified by sublimation, perhaps. We have often demonstrated this process by experiment. . . . Therefore, what Paracelsus here promises is not true" (18). Kircher had discovered what is well known to every schoolboy chemist today: that mercury on heating in air is converted to an oxide, and that further prolonged heating will reconvert this oxide to mercury.

Another chapter of the book asks and, according to Kircher's ideas, answers the question, "can one metal really be transmuted into another?" Kircher holds that "in theory such a transmutation is possible, but in practice I think that it could only be accomplished with the help of angels or devils." This assertion may be either a heavy, seventeenth century joke, or the expression of the very real belief many had at the time in the power of magic. It is more likely the former, since Kircher himself was twice accused of sorcery and only with great difficulty succeeded in proving his innocence. Such an accusation was no light matter at a time when witches were still being hunted in England, Germany, and elsewhere.

Kircher agreed with Roger Bacon who has said that "metalline materials," or minerals, could be changed into pure metals, for, says the Jesuit, "as I have shown in the eighth book, lead, bronze, gold, silver, etc., can be changed by nature into other metals. This is possible because they all possess a common matter, a vapour or a tenuous something of a sulphureo-salino-mercurial nature." But the question is, he continues, can man achieve such transformations by his own arts? Paracelsus held that he could, though only with great difficulty, and he proposed some experiments to prove his assertion. "So let us examine some of these experiments" (18).

Paracelsus gave a method for making copper by boiling iron filings in dilute vitriol. But Kircher often tried this experiment and found that the "copper" is nothing more than the iron filings coated with a thin layer of copper. His explanation of this happening is that "the bronze hidden in the vitriol" (we would say, the dilute sulfuric acid contaminated by a minute amount of copper sulfate) "from its natural affinity to iron rushes to it and sticks to it" (19). It is an early example of the well known experiment of coating the steel blade of a knife with copper by plunging it into a dilute solution of copper sulfate.

Paracelsus' prescription for making lead from iron is similarly shown to be the result of the misinterpretation of the results of the experiment. Kircher's investigations have shown the inaccuracy of this claim also.

The last chapter in his book on alchemy carries the title: "Pseudo-chemistry—concerning the frauds, deceits and other means by which alchemists have pretended to make pure gold, and which even today they have not ceased to practice" (20). Kircher had first-hand information on such fraudulent practices. It seems that many tricksters, the "confidence men" of his day, used to come to him and try to sell him their prescriptions for making gold. They knew that he was interested in all sorts of curious things, and that he was reputed to be rather credulous. But their hoped-for dupe was too clever for them. He would let them go on explaining their methods until they had implicated themselves, and then show that he knew their frauds. The legal penalties for such trickery could be very severe, and it was not long before these men were appealing to Kircher for mercy. He thus compelled them to reveal their tricks to him, and then, as he says himself, he would "let them go with an admonition and an alms."

By such means he learned many of the secrets of their slight-of-hand. One of these was the use of a hollow stick, plugged with wax and containing some gold dust. When they stirred their bubbling, boiling mixtures from which they claimed to be able to produce gold, the wax melted and the gold fell to the bottom of the vessel. Then, when their brew was ready, they showed their admiring audience the gold they had made.

Another of their tricks was to have the bottom of a metal vessel plated with gold and then covered with some soluble paint. When their gold-making mixture had boiled long enough, and they were sure that all the paint had dissolved off the bottom of the vessel, they emptied out the mixture and the gold-plated bottom was now revealed!

Thus ends the book on alchemy, the part of "Mundus Subterraneus" in which we are principally interested.

Fathers of Modern Chemistry

In 1665 Henry Oldenburg, Secretary of the Royal Society and editor of its *Philosophical Transactions*, complained in a letter to Boyle that he had been forced to pay more than forty shillings for Kircher's "Mundus Subterraneus" (8). He feared that he had not got his money's worth, but I wonder whether Boyle agreed with him?

Boyle must have felt that Kircher had answered his challenge of "The Sceptical Chymist" honestly, though perhaps without being aware that he was doing so. Boyle would have appreciated "Mundus Subterraneus," though he could not agree with everything in it. His own frequent, deferential references to the book in later writings show clearly his attitude toward its author. He certainly would have agreed with us in sharing, in some little way at least, "the fatherhood of modern chemistry" with Athanasius Kircher, the Jesuit Spagyrist at Rome.

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ENGINEERING TRAINING AT SAINT JOSEPH'S COLLEGE

John O'Conor, S.J.

To many "old grads" the above title may seem a strange one for an article on an institution known for over a hundred years as a liberal arts college. And that's what St. Joseph's still is. For, although the cooperative plan introduced in 1951 trains students to think as engineers, to work as engineers, to be recompensed as engineers, and to be promoted with engineers, it has as the basis of its bachelor of science degree that most fundamental of all the sciences, in the past graphically and aptly called "Natural Philosophy", and today known as Physics.

"Earn while you learn" is the keynote of the new Electronic Physics course whose enrollment has skyrocketed from a mere handful of physics majors to the third largest group on the campus.

How did this all come about? It was sparked by a suggestion made by Mr. Frank Folsom, now President of R.C.A.

Mr. Folsom, then executive Vice President of RCA Victor in Camden, was keenly aware of the continuing shortage of scientists trained in this field. He realized that many high school graduates interested in engineering could not afford the expense of four years at College and so to help increase the source of potential engineers he proposed the introduction of the cooperative plan which would take care of the students' needs financially and at the same time prepare them in the best possible way for a successful career in government or industry as electronic scientists.

As a result of further conferences between the authorities at the College and RCA representatives, a four-year course leading to a bachelor of Science Degree was evolved. This combines the rigorous fundamental training of a physicist with the practical "know how" characteristic of a good engineer. The degree is known as a B.S. in Electronic Physics, and qualifies the one who earns it both as a Physicist and as an electronic scientist.

Why has St. Joseph's selected the degree in Physics as the preferred one for cooperative students? Because Physics is the most basic of all natural sciences.

Many years ago Alexander Smith, Professor of Chemistry at Columbia University said: "The other sciences would be deaf, dumb and blind without the aid of Physics." That is true today, of the engineer as well as the pure scientist. It is interesting to note here in passing, that more than half the engineers in the National Academy of Science were trained as Physicists, and that such companies as General Electric and the Bell Laboratories stress fundamental Physics and Mathematics as the most important courses in their specialized training programs, given to college graduates.

One again may ask: Why emphasize *Electronic Physics?* For many reasons. Electronics is one of the fastest growing of the post war activities. When the first bulletin announcing the course was published electronics was a four billion dollar industry. Today it is a ten billion dollar one.

The country is going through what may be termed an electronic evolution.

In the cement kilns of Pennsylvania, in the copper mines of Montana, in the transportation systems of New York, in the cotton mills of Georgia, and in the oil refineries, tanneries and power plants throughout the country, electronic control and processing is taking over by what is now becoming known as automation. The computer business has mushroomed beyond all expectations, and the reason for the rapid advance is primarily electronic.

A glance at the want ads in the newspapers is sufficient to indicate the shortage of trained men in this field. This year less than 3,000 electrical engineers will be graduated; 30,000 are needed!

The cooperative program at St. Joseph's is similar to that offered in a number of other engineering colleges with one or two exceptions. The first two years include no industrial training. During this time Chemistry, Mathematics as well as Physics, languages and religion are studied.

After sophomore year, the student is selected by one of the seven cooperating institutions (RCA, Philco, IBM, Burroughs, Polyphase, Frankford Arsenal and the Naval Air Development center at the Philadelphia Navy Yard).

Beginning in June one-half the class spends the summer term in industrial practice, working as a paid employee of the Company or agency which has chosen him.

He is usually assigned as a "trainee" or assistant in one of the research or development laboratories.

The other half of the class attends a regular summer session of their Junior year, taking differential equations or advanced calculus, basic electronics, and as is the case with all St. Joseph's students at this level, an introduction to philosophy which includes logic and metaphysics.

At the time of the start of the Fall Session the two groups interchange places and the "workers" become students and visa versa. This alternation continues term by term until graduation. Senior year is occupied academically with additional advanced courses in mathematics, Physics and electronics as well as three additional branches of Philosophy; Psychology, Ethics and Natural Theology.

The entire curriculum is completed in four calendar years. Most other colleges offering the Co-op program take either five or six years, by reason of a greater number of work periods or because of the omission of all academic activity during the time of industrial practice.

How may we appraise the success of the Co-op venture?

In the four years of its operation, every student seeking permanent employment after graduation has been placed in industry.

Many have chosen to continue on for graduate degrees in Mathematics and Physics as well as engineering. Our graduates have won fellowships at the Universities of Delaware, Detroit, John Hopkins, Notre Dame, Pennsylvania, Purdue, Pittsburg, and Virginia. Graduates of 1954-1955 include a winner of the national Science Foundation fellowship in Physics and two others who received honorable mention, as well as one in Mathematics.

From this record it is evident that the training given does not neglect topics such as atomic and nuclear Physics as well as higher mathematics not usually required in an engineering curriculum.

The most rewarding result of the course is the reaction of the students.

Not only are they enthusiastic about the practical experience gained by working with graduate engineers, but they receive a new impetus and orientation with regard to subsequent work in the class room. They come back to college bursting with new ideas and ambitions. The monthly seminar in Physics is usually given by one of the Co-ops on his work during his last industrial assignment. Among the topics covered during the past year were: Color Television, Computer memory tubes, transistor operation and many others of a more specialized nature.

In addition to the benefits of regularly scheduled college laboratory periods and the experience gained in industry, the student of Electronic Physics has an opportunity at St. Joseph's to become a member of a research team working on the properties of "semi-conducting" materials.

"Semi-conductors" are used in the making of transistors, those fascinating finger-nail size elements that give promise of replacing vacuum tubes in many electronic circuits. Under the direction of Dr. Charles Kriessman, research Physicist, samples of such materials are being prepared for investigation and study. This involves high temperature work both in the making and testing of the sample. Thus many techniques are learned and put in practice while the student cooperates in advancing our knowledge of "solid state" Physics.

What does the future hold for the cooperative Electronic Physics Course at St. Joseph's?

According to the U. S. Office of Education, Bulletin 11, 1954, on cooperative education, there are only thirty-five accredited colleges offering programs of this type. Every month additional companies and branches of the armed services are writing in to seek agreements which will combine the educational facilities of the College with the "On-the-Job" training of their own establishments. Each year students are applying in larger number for enrollment as

"Co-ops". It seems both providential and inevitable that this method of education should expand and become one of the great factors in helping this nation fulfill its destiny as world leader. It will do so as long as the following are adhered to and reduced to reality.

1. Preserve and seek the identical ultimate educational aims that have been characteristic of St. Joseph's College for one hundred years.

2. Impart a first hand, actual knowledge of and experience with, the execution in industry of engineering designs, projects and developments.

3. Assist students, by direct and personal experience, to test their aptitude for a scientific career.

4. Impart understanding of and familiarity with the problems and viewpoints of working men and women.

5. Enable students to adjust themselves to industrial employment by gradual and easy transition from academic pursuits and mode of life to the requirements of modern production methods.

6. To train and prepare students for administrative and operating functions which, to a greater or lesser degree, enter into most engineering careers.

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Weston - Mathematics
GARBER, STEPHEN A. (MD)
Auriesville - Chemistry
GERRY, REV. STANISLAUS T. (NE)
Baghdad - Biology
GERSITZ, JOSEPH F. (NY)
McQuaid H.S. - Mathematics
GIBBONS, THOMAS (NE)
Baghdad - Physics
GLOSTER, GEORGE (NE)
Baghdad - Physics
GLOVER, FRANCIS N. (PI)
Woodstock - Physics
GRAHAM, REV. EDGAR B. (MD)
Poona - Physics
GRANT, WALTER J. (NE)
Boston College H.S. - Physics
GRAZIANO, GEORGE (NY)
Japan - Chemistry
GREEN, JOHN W. (NE)
Pomfret - Mathematics
GREEN, THOMAS P. (NY)
Xavier H.S. - Mathematics
GREENE, FRANCIS A. (MD)
Gonzaga H.S. - Physics
GREENE, REV. MERRILL F. (NE)
Weston - Science and Phil.
GRUSZCZYK, REV. JEROME H. P. (NY)
St. Peter's College - Biology
GUAY, REV. LEO J. (NE)
Baghdad - Chemistry
GUINDON, REV. WILLIAM G. (NE)
Boston College - Physics
GUTH, EDWARD L. (NY)
St. Peter's Prep - Physics
HAIG, FRANK R. (MD)
Catholic U. - Physics
HAMMETT, REV. J. W. (MD)
Gonzaga - Chemistry
HANDRAHAN, JOHN B. (NE)
Spain - Mathematics
HANZELY, REV. JOSEPH B. (MD)
Wheeling - Biology
HARLEY, REV. JAMES L. (MD)
Loyola College - Biology
HARPER, RICHARD H. J. (MD)
Woodstock - Mathematics
HARRIGAN, PHILLIP K. (NE)
Weston - Mathematics
HARRY, ALWYN C. (NE)
Pomfret - Biology
HAUBER, REV. EDWARD S. (MD)
Loyola College - Chemistry
HAUS, ROBERT A. (NY)
Woodstock - Mathematics
HEIM, REV. HOWARD J. (MD)
Catholic U. - Physics
HENNESSEY, REV. GERALD J. (NE)
Kingston, B.W.I. - Biology
HENNESSEY, REV. JAMES J. (PI)
Baguio - Meteorology
HERRITY, JOHN F. (MD)
St. Joseph's H.S. - Mathematics

HEYDEN, REV. FRANCIS J. (NY)
Georgetown U. - Astronomy
HILSDORF, REV. GEORGE J. (NY)
St. Peter's College - Chemistry
HOAR, RICHARD J. (NY)
Woodstock - Physics
HOHMAN, GEORGE R. (MD)
Woodstock - Physics
HOMANN, FREDERICK A. (MD)
St. Louis U. - Mathematics
HOODACK, REV. JOHN J. (NY)
Regis - Chemistry
HUFNAGLE, REV. ALVIN A. (NY)
Brooklyn Prep - Chemistry
HUTCHINSON, REV. GERALD F. (NE)
Fairfield U. - Chemistry
JENEMANN, ALBERT H. (MD)
Loyola H.S. - Chemistry
JOHNSON, THOMAS A. (NE)
Weston - Mathematics
JUDGE, KENNETH M. (MD)
Jamshedpur - Chemistry
KECK, ROBERT J. (NY)
Caroline Islands - Physics
KEHOE, ARTHUR G. (NY)
Woodstock - Chemistry
KELLEY, REV. JOSEPH M. (NY)
Loyola H.S., Balt. - Physics
KELLY, EDMUND F. (NE)
Weston - Mathematics
KELLY, FREDERICK W. (NE)
Weston - Mathematics
KENNA, RICHARD A. (MD)
Woodstock - Mathematics
KERDIEJUS, JOHN B. (NE)
Weston - Physics
KILMARTIN, EDWARD J. (NE)
Pomfret - Chemistry
KINNIER, REV. JOHN H. (NE)
Weston - Physics
KIRSCH, REV. SIMON C. (MD)
Jamshedpur - Physics
KOEHLER, REV. C. FREDERICK (MD)
Loyola College - Mathematics
KRIEGER, GEORGE L. (MD)
St. Joseph's H.S. - Mathematics
LANDREY, REV. GERARD M. (NE)
Boston College - Chemistry
LANGGUTH, REV. LAURENCE C. (NE)
Fairfield U. - Physics
LARKIN, REV. WILLIAM J. (NE)
Boston College - Physics
LASCHENSKI, SIGMUND J. (MD)
Woodstock - Physics
LAWLOR, REV. GEORGE F. (NE)
Boston College - Biology
LELLII, RAYMOND (MD)
Gonzaga H.S. - Biology
LEWIS, REV. CHARLES J. (NY)
Fordham U. - Mathematics

LINEHAN, REV. DANIEL (NE)
Weston - Physics
LIUIMA, REV. FRANCIS A. (LITH).
Boston College - Physics
LORENZO, MICHAEL L. (MD)
St. Louis U. - Biology
LYNCH, REV. FRANCIS X. (PI)
U. of Chicago - Anthropology
LYNCH, REV. J. JOSEPH (NY)
Fordham U. - Physics
LYNCH, REV. JOSEPH P. (NY)
Le Moyne - Biology
MAHLMEISTER, ALVIN S. (NY)
Canisius H.S. - Mathematics
MARASIGAN, REV. VINCENT (PI)
Cebu - Physics
MARROW, STANLEY B. (NE)
Baghdad - Chemistry
MARTUS, REV. JOSEPH A. (NE)
Holy Cross - Chemistry
MAY, REV. EDWARD N. (NY)
St. Peter's H.S. - Mathematics
MacCORMACK, REV. ANTHONY J. (NE)
Holy Cross - Biology
MacDONNELL, JOHN J. (NE)
Weston - Mathematics
MacDONNELL, REV. ROBERT B. (NE)
Holy Cross - Physics
MacENTEE, FRANCIS J. (MD)
Münster - Biology
MacKINNON, EDWARD M. (NE)
St. Louis U. - Physics
MacLEAN, DONALD I. (NE)
Catholic U. - Chemistry
McBRIDE, WILLIAM H. (NY)
Woodstock - Chemistry
McCAFFREY, REV. JAMES P. (NE)
Boston College H.S. - Mathematics
McCARTHY, ALAN J. (NY)
Xavier H.S. - Biology
McCARTHY, REV. JOHN J. (NE)
Boston College - Physics
McCARTHY, JOHN J. (NE)
Weston - Physics
McCARTHY, MARTIN F. (NE)
Pomfret - Physics
McCARTHY, PAUL J. (NY)
Woodstock - Chemistry
McCAWLEY, REV. EDWARD W. (NY)
Gonzaga H.S. - Physics
McCLUSKEY, REV. RAYMOND E. (NE)
Kingston, B.W.I. - Physics
McCONNELL, REV. BERNARD J. (MD)
Scranton U. - Mathematics
McCOY, REV. DANIEL F. (NY)
Sophia U., Tokyo - Biology
McDEVITT, REV. EDWARD L. (NY)
Xavier H.S. - Physics
McDONALD, JOHN J. (NY)
Woodstock - Mathematics

McDONALD, ROBERT F. (NY)
McQuaid H.S. - Mathematics
McDONOUGH, LEO J. (NE)
Pomfret - Mathematics
McELANEY, JAMES H. (NE)
Weston - Physics
McGRATH, REV. JOHN J. (NE)
Fairfield U. - Physics
McGRATH, WILLIAM J. (MD)
Georgetown U. - Mathematics
McGUINN, REV. ALBERT F. (NE)
Boston College - Chemistry
McGUIRE, JOHN F. (NE)
Weston - Mathematics
McKEOUGH, JAMES A. (NY)
Pomfret - Biology
McLAUGHLIN, NEIL P. (MD)
Loyola H.S. - Physics
MERRICK, REV. JOSEPH P. (NE)
Bagdad - Mathematics
MILLER, HENRY J. (MD)
Weston - Seismology
MILLER, REV. RICHARD A. (NY)
Fordham U. - Physics
MILLER, REV. WALTER J. (NY)
Fordham - Astronomy
MOLLOY, REV. JOSEPH J. (MD)
St. Joseph's College - Chemistry
MONAGLE, REV. JAMES H. (NE)
Weston - Mathematics
MOORE, DONALD J. (NY)
McQuaid H.S. - Mathematics
MORRIS, REV. JOHN F. (NE)
Weston - Chemistry
MUENZEN, REV. JOSEPH B. (NY)
Canisius College - Chemistry
MULLEN, REV. JOSEPH E. (NE)
Holy Cross - Mathematics
MULLIGAN, REV. JOSEPH F. (NY)
Fordham - Physics
MURRAY, REV. JOHN P. (NE)
Fairfield U. - Mathematics
MURRAY, REV. JOSEPH L. (NE)
Cranwell - Physics
MURRAY, JOSEPH G. (NY)
Regis H.S. - Mathematics
MURRAY, JOSEPH W. (NY)
Fordham U. - Biology
MUSSELMAN, REV. JOSEPH G. (NY)
Canisius H.S. - Mathematics
NETTER, DONALD F. (MD)
St. Joseph's H.S. - Physics
NOLAN, GEORGE W. (NE)
Pomfret - Physics
NORMAN, RICHARD W. (MD)
Poona - Physics
O'BRIEN, DANIEL J. (NY)
Fordham - Mathematics
O'BRIEN, REV. JOHN J. (NY)
Le Moyne - Chemistry

O'BRIEN, ROBERT Y. (MD)
Woodstock - Chemistry
O'CONNELL, EDWARD P. (MD)
Woodstock - Mathematics
O'CONNOR, FRANCIS C. (NY)
Woodstock - Mathematics
O'CONNOR, REV. JOHN S. (NY)
St. Joseph's College - Physics
O'MALLEY, THOMAS F. (NY)
Brooklyn Prep - Physics
O'SHEA, REV. EDWARD F. (MD)
Scranton U. - Mathematics
O'TOOLE, LAURENCE J. (NE)
Weston - Chemistry
OWENS, JOHN V. (NE)
Weston - Biology
PANUSKA, JOSEPH A. (MD)
St. Louis U. - Biology
PAQUET, JOSEPH A. (NE)
Baghdad - Physics
PENDERGAST, RICH. J. (NY)
Brooklyn Prep - Physics
PERSICH, REV. JOSEPH A. (NY)
Canisius High - Mathematics
PICKETT, EDWARD M. (NY)
Fordham Prep - Physics
POMEROY, JOSEPH B. (NE)
Holy Cross - Physics
POWERS, REV. EDWARD R. (MD)
Scranton U. - Mathematics
PRIESTNER, REV. JOSEPH A. (PI)
Manila - Physics
PROCTOR, BURTON J. (MD)
Georgetown Prep - Mathematics
RAFTERY, WILLIAM J. (NE)
Weston - Massachusetts
REAGAN, REV. JOHN D. (NY)
Xavier H.S. - Chemistry
REARDON, REV. TIMOTHY P. (NY)
Shrub Oak - Mathematics
REUSHER, J. A. (MD)
Loyola H.S. - Mathematics
RING, REV. JAMES W. (NE)
Boston College - Physics
ROHR, JOHN J. (PI)
Cagayan - Physics
ROONEY, REV. ALBERT T. (NY)
Shrub Oak - Physics
ROONEY, FRANCIS V. (NY)
Xavier H.S. - Biology
RUDDICK, JAMES J. (NY)
Woodstock - Physics
RUGGIERI, GEORGE D. (MD)
St. Louis U. - Chemistry
RUPPENTHAL, REV. WILLIAM J. (MD)
Loyola H.S., Baltimore - Mathematics
RYAN, REV. JOSEPH L. (NE)
Baghdad - Chemistry
SARGEANT, FRANK (NE)
Kingston, B.W.I. - Mathematics

SCHMITT, WILLIAM J. (PI)
Woodstock - Chemistry
SCHUBERT, REV. CLARENCE C. (NY)
Princeton - Chemistry
SCHUH, REV. JOSEPH E. (NY)
St. Peter's College - Biology
SCULLY, BERNARD M. (NE)
Weston - Chemistry
SHEA, WALTER B. (NE)
Weston - Chemistry
SHEEHAN, JAMES T. (NE)
Fairfield Prep - Chemistry
SHEEHAN, REV. WILLIAM D. (NE)
Baghdad - Physics
SKEHAN, REV. JAMES W. (NE)
Pomfret - Geology
SMITH, JAMES F. (NY)
Canisius H.S. - Physics
SMITH, REV. THOMAS J. (NE)
Holy Cross - Physics
SOHON, REV. FREDERICK W. (MD)
Georgetown U. - Mathematics
SPILLANE, REV. THOMAS J. (NE)
Boston College - Mathematics
STAEBEL, REV. FRANCIS J. (NY)
McQuaid H.S. - Mathematics
SU, SERGIO S. (PI)
Weston - Seismology
SUCHAN, WILLIAM T. (NY)
Woodstock - Physics
SULLIVAN, DANIEL J. (NY)
McQuaid H.S. - Biology
SULLIVAN, REV. JOHN W. (NE)
Boston College H.S. - Mathematics
SULLIVAN, REV. ROBERT J. (NE)
Baghdad - Anthropology
SULLIVAN, REV. WILLIAM D. (NE)
Catholic U. - Biology
SWORDS, REV. RAYMOND J. (NE)
Holy Cross - Mathematics
THOMAN, CHARLES J. (MD)
Fordham - Chemistry
TOBIN, REV. JOHN A. (NE)
Boston College - Physics
TRZASKA, JOHN R. (NE)
Catholic U. - Chemistry
VALANCE, EDWARD H. (NY)
Fordham - Chemistry
VARELA, MIGUEL M.
Woodstock - Chemistry
VARNERIN, ROBERT E. (NE)
Weston - Chemistry
WALSH, JOSEPH P. (NE)
Weston - Physics
WALSH, REV. MICHAEL P. (NE)
Boston College - Biology
WARD, WILLIAM H. (NY)
Fordham Prep - Chemistry
WATSON, REV. JOSEPH T. (NY)
Xavier H.S. - Physics
WILKIE, REV. FRANCIS X. (NE)
Fairfield U. - Biology
WILSON, C. M. (Phil.)
Cagayan - Physics
WINSLOW, REV. REGIS B. (MD)
Loyola College - Physics
WOODS, JAMES A. (NE)
Cranwell Prep - Mathematics
WOODWARD, JOHN B. (MD)
Woodstock - Physics
YAKAVONIS, EDWARD C. (MD)
Woodstock - Mathematics
ZEGERS, REV. THEODORE A. (NY)
St. Peter's College - Physics

It would be appreciated if any errors of commission or omission are brought to the attention of the Secretary of the Association.

News Items

HOLY CROSS COLLEGE — DEPARTMENT OF CHEMISTRY

Course changes in recent years include Advanced Organic Synthesis in the eigth semester (replacing SM Ultimate Organic Analysis) and a third semester of physics (electric measurements) during the fifth semester. Mathematics is reduced to four semesters and includes Introduction to Calculus, Calculus and Differential Equations. On Monday, February 27, 1956 The Cross and Crucible Chemists Club was host to the high school students of Worcester County for an Open House in the Department of Chemistry. About 400 students and many of their teachers attended. Live demonstration experiments and scientific movies were featured. The list of honorable mentions in the National Science Foundation's 1956 examinations include three Holy Cross Chemists of the class of '56. By a fortunate coincidence the College has acquired a long back run of the Journal of the Chemical Society from the library of Sir William Crookes. His personal bookplate carries the appropriate emblem, *Ubi Crux Ibi Lux* Personnel extra-curricular activities include, science fair judging, and helping in the celebration of Chemical Progress Week by speaking at various high schools. Fr. Martus was elected Secretary of the New England Association of Chemistry teachers. He is liaison between his association and the local ACS section on summer jobs for teachers. Dr. VanHook is the beneficiary of a grant from Sugar Research Foundation, N.Y., for work on sugar crystallization during the year 1956-57. Fr. Martus has been selected for a fellowship at the Oak Ridge Summer Institute of Nuclear Studies.