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John N. Schumacher

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I. FOUNDATION AND EARLY YEARS, 1865-1897

IT was a memorable day in the history of Philippine science when a young Jesuit scholastic, professor of mathematics and physics at the Ateneo Municipal of Manila, began his systematic observations of the weather just a hundred years ago[1] Impelled by his own scientific interests, Francisco Colina, S.J., had set up for himself a few simple instruments to make primitive observations on the weather two or three times a day. When another recently-arrived scholastic, Jaime Nonell, S.J., who had had a little experience before coming to the Philippines in the modest meteorological observations of his seminary physics professor, saw the terrible destruction wrought by a strong typhoon later that year, he made use of Colina's observations, taken every hour during the typhoon.

[1] Actually, it seems that observations were made even before 1865, but the systematic recording of them dates from the beginning of that year. The principal sources on the history of the Observatory to 1900 are Miguel Saderra Masó, S.J., *Historia del Observatorio de Manila, 1865-1915* (Manila: McCullough, 1915); and Pablo Pastells, S.J. *Misión de la Compañía de Jesús en Filipinas en el siglo XIX* (3 vols.; Barcelona: Editorial Barcelonesa, 1916). For the events till 1870 Pastells based himself on an account written for him in 1912 by Father Jaime Nonell, S.J. Saderra Masó had at his disposal the archives of the Observatory, destroyed in 1945.

to plot their curves. These curves, together with an account of the typhoon written by Colina, were printed as a supplement by the editor of the *Diario de Manila.* This leaflet may justly be called the precursor of a long series of scientific publications from the hands of the Jesuits of the Manila Observatory.

This simple publication attracted the attention of various businessmen, merchants, and mariners in Manila, who approached the Jesuit Superior, Father Juan Vidal, with the request that the Jesuits undertake to make regular observations for the public, so as to study the laws which governed typhoons and thus provide an immense humanitarian service to the Philippines by making it possible to give warning of their approach. When the two young Jesuits who had done the original observations replied that it was impossible to do such serious scientific work with the rudimentary and antiquated instruments they possessed, the group of businessmen offered to finance the purchase of proper instruments in Europe. The Jesuit Superior felt obliged to accede to these repeated requests, and made arrangements with the funds provided to purchase the Universal Meteorograph, then recently invented by Father Angelo Secchi, S.J., of the Vatican Observatory.

The following year there arrived in Manila the young Federico Faura, S.J., whose scientific and mathematical abilities had already attracted the attention of his superiors and caused them to designate him, still a scholastic, to direct the fledgling observatory. Under his direction the Observatory was put on an organized basis, particularly when the arrival of the Secchi meteorograph in 1869 made possible the continuous recording, day and night, of meteorological observations. Communications had already been set up with other observatories in Europe and America when Father Faura returned to Spain in 1871 to complete his studies for the priesthood and further to acquaint himself with the methods employed in European observatories.[2]

[2] Pastells, I, 171-174; Saderra, pp. 23-27.

The significance of the foundation of an observatory by the Jesuits in Manila at this time may best be appreciated by reflection on the state of scientific endeavor in Spain at the time, and of the infant state of meteorology, not only in Spain, but in the world as a whole. The cultural decadence of which Spain was a victim almost to the end of the nineteenth century, largely due to the series of civil wars and changes of government, was nowhere more evident than in physical science, which precisely at this period was seeing such a phenomenal growth in the rest of Europe.[3] In the world as a whole, moreover, meteorology had emerged as a science only towards the middle of the century, and the first international congress of meteorology was held in 1853. Between 1850 and 1875 the nations of Europe and America began to establish networks of weather stations for systematic observation.[4] In Spain these meteorological observations were first regularly published for Madrid in 1860, and for the provinces in 1865.[5] None of the observatories in Asia still in existence had yet been founded when the Manila Observatory took its first halting steps in 1865.[6] One can only admire the scientific-mindedness of the Spanish Jesuits of this period to whom it was due that, even though cut off from the great scientific centers of Europe and America, Manila could be found, at least in meteorology, in step not only with Peninsular Spain, but with the more scientifically advanced countries of the world.

During Father Faura's years of absence from the Philippines (1871-1877), the work of observations went on under a series of directors, and though such continued changes prevented any long-range work, the data accumulated during these years was ready at hand for Father Faura on his return, and made it possible for him to move quickly towards the goal which the Observatory had set for itself from the be-

[3] "España: ciencias exactas," *Enciclopedia universal ilustrada europeo-americana*, XXI, 1119-1120. [*Espasa*]

[4] "Meteorology," *Encyclopedia Britannica*, 1956 ed., XV, 341.

[5] *Espasa*, XXI, 1124-1125.

[6] The Russians had founded one in Peking earlier, but it long ago went out of existence. See Saderra, p. 23.

ginning—the determination of the laws of typhoons, and the consequent ability to predict their course.[7] During this period of accumulation of data, the equipment of the Observatory was also being increased and improved. The funds for this equipment came in part from a grant of the Ayuntamiento of Manila, but principally from further voluntary subscriptions from grateful businessmen of the city, which, in addition to the 6000 pesos raised for the first instruments, amounted to 7,542 pesos more in the years 1872-1877. Thanks to these funds the Observatory was able to build a structure more apt to its need above the Mission House facing the old Ateneo in Intramuros.[8]

On his return to the Philippines, Father Faura immediately set himself to study the data accumulated during the previous years. By 1879, after comparison of these observations with the work on the hurricanes of the West Indies published by his fellow-Jesuit of the observatory of the Colegio de Belén in Havana, Father Benito Viñas, he felt ready to issue typhoon warnings. On July 7, 1879 he warned of a typhoon crossing northern Luzon, and in November predicted a strong one in Manila. Relying on the accuracy of his July prediction, the government took all precautions, and the consequent escape from all but slight losses, in contrast to what happened in places unable to be reached by Father Faura's warning, permanently established the reputation of the Observatory.[9] From then until World War II, typhoon warnings were to be a major service of the Observatory, always enjoying the complete confidence of the people of Manila, and later of the whole Orient, as the warnings were extended to a wider range.

The recognition of the Observatory internationally had been growing continually, and more and more foreign observatories requested the monthly *Boletín del Observatorio de Manila.* In 1880, once the submarine cable between Manila and Hong Kong had been laid, the Governor of the British colony was immediately requested by Hong Kong businessmen

[7] Saderra, pp. 27-28.

[8] Pastells, I, 179-181; Saderra, pp. 28-29.

[9] Saderra, pp. 36-40.

to petition the transmission of the Observatory's typhoon warnings and other meteorological information to Hong Kong. Shortly afterward when there was question of the British colonial government establishing an observatory of its own to help complete the meteorological coverage of the China Sea, it was to Father Faura that the Governor turned for advice in the planning which proceeded its opening.[10]

Meanwhile, the request of the Governor of Hong Kong for the services of the Manila Observatory had brought forward once more the project of making the Jesuit enterprise an official institution with support from the Spanish government. The initiative seems to have come from the Chief of the Telegraphic Service, D. José Batlle, who had already put the facilities of the Service at the disposal of Father Faura to the extent then possible. In spite of the unanimous recommendations of the junta set up in Manila by Governor-General Fernando Primo de Rivera in 1881, the trammels of bureaucracy held up the final resolution of the matter until 1884. On April 28 of that year a Royal Decree recognized the Manila Observatory as being an official institution under the direction of the Jesuit Fathers, and established a network of meteorological stations dependent on the Observatory.[11]

Consequent on the Royal Decree, the years 1884 and 1885 saw the establishment of secondary stations, generally connected with the telegraph stations, in various strategic points in Luzon. In 1885 the time service also began to function for the benefit of ships, as well as a system of semaphoric weather warnings, first for the port of Manila, and gradually for others of the Archipelago as well.[12] The increased activity and responsibilities of the official meteorological service made imperative more ample and suitable quarters, and in 1886 the transfer was made to a site in Ermita where the new Normal School, likewise directed by the Jesuits, was just being

[10] *Ibid.*, pp. 30-31, 63-68; Pastells, I, 179-180.

[11] Saderra, pp. 73-80; Pastells, II, 75-79. The Royal Decree was promulgated in the *Gaceta de Manila* XXIV-I (17 Junio 1884), pp. 706-707.

[12] Saderra, pp. 81-86; Pastells, II, 81, gives the incorrect date of 1883.

constructed. The street on which the Observatory was located was later to be re-named Calle Padre Faura by a grateful Ayuntamiento of Manila, a name which it still bears.[13]

This same year saw the appearance of the Faura Aneroid Barometer, which made available to the general public an instrument for announcing the approach of a typhoon. The fruit of his observations of typhoons and their accompanying phenomena, the barometer was actually a graphic expression of the laws laid down by Father Faura in 1882 in his publication *Señales precursoras de un temporal.* Almost immediately the barometers were sought on every side, and widely used on land and sea until replaced by Father Algué's barocyclonometer.[14]

With the official status now held by the Observatory, and its adequate new quarters, Father Faura was able to carry out his long-cherished dream of setting up a complete observatory. Forced to return to Spain in 1888 because of his failing health, he took advantage of his presence in Madrid to seek the approval of the Overseas Minister, Manuel Becerra, for the official establishment of a seismological and a magnetic section in the Observatory. Becerra, who was former Grand Master of the Masonic Gran Oriente de España, and whose term as Minister saw a determined effort to destroy the influence of the religious orders in the Philippines, particularly in education, showed himself most benevolent to Father Faura and an enthusiastic promotor of the Observatory, sponsoring both the seismological and magnetic sections.[15]

Already in 1887 a section devoted to the study of terrestial magnetism had been set up, with Father Martín Juan, newly arrived from his studies in Europe, in charge. Father Juan soon set out on a trip through the southern islands to

[13] Saderra, pp. 87-90; Pastells, II, 326.

[14] Saderra, pp. 95-97; Pastells, II, 82. Father Faura's description of the barometer and its operation may be found in an appendix to *the Cartas de los Padres de la Compañía de Jesús de la Misión de Filipinas,* VII, 309-325.

[15] Saderra, pp. 99-100, which rectifies in part the account in Pastells, II, 222, 224-225.

make the magnetic observations necessary to construct a magnetic map of the Philippines. After observations in Palawan, Jolo, and much of Mindanao, Father Juan was stricken with fever in Surigao in July 1888 and died there. His successor, Father Ricardo Cirera, who arrived the following year, was able to complete the series of observations for the Visayas and Luzon, and in 1893 published the first maps of the terrestrial magnetism of the Philippines. Meanwhile the work had been completed on the magnetism building in Manila, and once the section received official recognition in 1890, the hourly magnetic observations of Manila likewise appeared in the Monthly Bulletin of the Observatory, with the meteorological.[16]

As in the study of terrestial magnetism, so also in seismology, the Observatory had begun its studies long before any official recognition and support was given by the Spanish government. During the series of severe earthquakes of 1880 Father Faura had made continual observations with the two rudimentary pieces of seismological apparatus the Observatory then possessed. So impressed was the city of Manila by his work during the eight days of earthquakes, that the Ayuntamiento voted unanimously to name him "Adopted Son of Manila." The results of Father Faura's observations drew considerable attention abroad, since seismology was then in its infancy, and the principal institutions for its study, in Japan and Italy, had only been founded the previous year. Father Faura's were perhaps the first actual curves reproducing the action of an earthquake which had been obtained from the then newly-invented seismographs. They were widely reproduced throughout the world, and appeared in practically all treatises on seismology published during a number of years afterwards.[17]

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[16] Pastells, II, 83-89; Saderra, pp. 101-109. Father Cirera was later to be the founder of the astrophysical Observatorio del Ebro in Tortosa, Spain. The results of the work of Fathers Juan and Cirera are contained in the book *El magnetismo terrestre en Filipinas* (Manila: Chofre, 1893).

[17] Saderra, pp. 45-53.

With the official establishment of the section of seismology in 1890, the newly-appointed director, Father Miguel Saderra Masó, undertook the setting up of a network of secondary seismic stations throughout Luzon, in connection with the telegraphic system, while obtaining a number of corresponding observers in the Visayas and Mindanao, where the telegraph had not yet reached. The central station in Manila was equipped with the latest developments in seismographs, and the seismological observations also began to appear in the Monthly Bulletin beginning in 1890.[18]

The final section of the Observatory planned by Father Faura, the astronomical, he was not to see in operation. From 1888 onwards his health became progressively worse, and despite several periods of rest in Spain, Japan, and the United States, all of which he utilized to further his knowledge and to advance the work of the Observatory, he died on January 23, 1897. One of the last times he left the house before his death was his trip to the cell of Fort Santiago where his former student, José Rizal, was awaiting execution. The meeting was one of deep emotion for both men, and though no doubt happy that Rizal had returned to the Church before he died, Father Faura was too overcome with grief in his weakened condition to accompany Rizal to his execution the next morning, together with the other Jesuits who assisted him in his last moments.[19]

At his death Father Faura left the Observatory practically complete as he had envisioned it, with only the facilities of the astronomical section still in process of completion. All of it was principally, not to say exclusively, his work. He had the personal and scientific esteem of all, not only within the Philippines, but in international scientific circles, as the honors given him by European scientific societies and his representation of Spain and the Philippines at a number of international scientific congresses testify. With the completion

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[18] *Ibid.*, pp. 112-113.

[19] Saderra, pp. 120-123; Pastells, III, 124-130, 296; James J. Hennessey, S.J., "The Manila Observatory," *Philippine Studies* VIII (1960), 105, n. 5, citing D. Román Trinidad.

of the astronomical section in 1899, the Manila Observatory was judged by a Spanish scientist to be the finest and most complete in Orient, and under some aspects, superior to any in Spain.[20]

II. FATHER ALGUE AS DIRECTOR, 1897-1925

The successor whom Father Faura had prepared for himself, who was to continue and further advance his pioneering work, was Father José Algué, sub-director of the Observatory since 1894, after several years of preparation in the observatories of Europe and America. In the observatory of Georgetown University he had invented a zenith telescope, which gave the most accurate latitude measurements yet achieved for that place. Unfortunately, though he set up a similar instrument in Manila, the pressure of other occupations after he became Director, prevented him from ever carrying out any of the work he had planned along this line.[21] In the few years since his arrival in 1894 in Manila, Father Algué had already done considerable work in meteorology, publishing an important study entitled *Baguios o ciclones filipinos* in 1897, in which, making use of the stores of information on typhoons gathered through the years by the Observatory, he further developed the earlier conclusions of Father Faura on the origin, laws, and accompanying phenomena of typhoons. It was in this study that he first presented to the public his barocyclonometer, which improved on Father Faura's barometer, to enable mariners and others to determine with considerable accuracy the distance and direction of a typhoon center. The barocyclonometer became standard equipment on all ships in East Asian waters for many years to come, as well as widespread throughout the Philippines, until the progress of radio communications on ships made it no longer necessary. In 1904 Father Algué would issue an English edition of his study of typhoons, enlarging its scope as a result of his subsequent research, to cover the entire Orient.[22]

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[20] Pastells, III, 121-122.

[21] Saderra, pp. 129-130.

[22] *Cyclones of the Far East* (Manila: Imprenta del Gobierno, 1904). See Pastells, III, 312-313; Saderra, pp. 123, 161; William C. Repetti, S.J., *The Manila Observatory* (Washington, 1948), pp. 32-33.

The events of the years 1898-1901 were to show the high esteem in which the Manila Observatory was universally held. During the blockade of Manila after destruction of the Spanish fleet by the Americans under Admiral George Dewey, the admirals and most of the officers of the German, French, British, and Japanese fleets standing by in Manila Bay came to pay visits to the Observatory, and to express their interest and appreciation of the work being done there. A concrete proof of this interest was the commendation of the Observatory then made to Admiral Dewey, so that the latter gave orders that great care should be taken not to harm it in case of bombardment of the city, as he himself later told Father Algué. As the American and Filipino Revolutionary troops pushed the Spaniards back toward the Walled City, there was considerable danger in the Observatory, as it was in the line of fire, but Fathers Algué and Doyle remained there to the end, treated with respect by both American and Filipino troops, the latter of whom requested Father Algué to come and offer Mass for them, which he did in the Ermita parish church.[23]

As soon as the American troops had occupied the city, they requested Father Algué to resume typhoon warnings. In a lengthy interview and dinner Father Algué had with Admiral Dewey aboard his flagship in November, the latter could not find terms high enough to praise the work of the Observatory, and promised to recommend the support of the American government for it.[24] The most eloquent proof of all, however, came in 1899, when the director of the Hong Kong Observatory, apparently out of professional jealousy, made a slanderous attack on the competency of the Manila Observatory to Washington. When, as a result, the Jesuits were ordered to cease sending reports to Hong Kong, not only the businessmen, newspapers, and shipping of Manila, but likewise foreign naval commanders, the newspapers of Hong Kong, and the Hong Kong government itself protested, giving unanimous testimony to the appreciation in which the Manila Observa-

[23] Saderra, p. 124; Pastells, III, 332-333, citing a letter of Father Algué to Father Luís Adroer, S.J., the Jesuit superior in Spain.

[24] Pastells, III, 336-337.

tory was held throughout the Orient. The prohibition was immediately lifted by American authorities, and the reputation of the Observatory remained securely established for the future.[25]

With the cessation of Spanish government support for the Observatory in 1899, the American Military Government under General Otis undertook to continue to maintain it on a provisional basis. That same year the first Philippine Commission under Jacob Schurman arrived in the Philippines to study conditions and to make recommendations for its future government. The members of the Commission, especially Colonel Charles Denby and Professor Dean C. Worcester, showed great interest in the Observatory, and invited Father Algué to draw up plans for a reorganization of the Meteorological Service and its recognition on a permanent basis by the American government. At the same time the Commission interested itself in the work which the Jesuits who had been concentrated in Manila due to the circumstances of the War, had been compiling under the direction of Father Algué. As finally published this work consisted of two large volumes, the first containing data on the ethnology, geography, culture, history, etc., of the Philippines; the second giving the results of the climatological, seismological, and magnetic research done by the Manila Observatory up to 1900.[26] Though the first volume is not all of equally high quality, being compiled, as it was, in a short time and under difficult circumstances, the second is of the highest scientific value, and both of them were eagerly sought by the Philippine Commission in the dearth of reliable information on the Philippines available to them. At

[25] Saderra, pp. 133-136; Pastells, III, 349-354. The entire correspondence on the affair with a large selection of the testimonials to the work of the Observatory from many sources may be found in the pamphlet published by the Observatory on the occasion: *El servicio meteorológivo del Observatorio de Manila vindicado y rehabilitado* (Manila: Imprenta del Observatorio, 1899).

[26] *El Archipiélago Filipino*: Colección de datos geográficos, estadísticos cronológicos y científicos, relativos al mismo, entresacados de anteriores obras ú obtenidos con la propia observación y estudio por algunos Padres de la Misión de la Compañia de Jesús en estas islas (Washington: Imprenta del Gobierno, 1900).

their suggestion, Father Algué and Clos were given a commission to go to Washington to see to the publication of *El Archipiélago Filipino* at the Government Printing Office, together with the *Atlas de Filipinas*, compiled by Father Algué himself, the first work of its kind for the Philippines. The two volumes of *El Archipiélago Filipino* were also printed by the Commission as the third and fourth volumes of its *Report* in 1900.[27]

While in Washington Father Algué had an interview with President McKinley and various conferences with other officials of the American government in connection with his plans for the organization of the Philippine Weather Bureau. He was also frequently consulted by those in Washington charged with Philippine affairs and asked for reports on various subjects.[28]

On his return to the Philippines in 1901, Father Algué's first task was to see to the setting up of the Weather Bureau as envisioned in the plan he had presented to the Philippine Commission. With the establishment of civil government in the Philippines, the Commission began to function as a law-making body, and in May 1901 passed a law providing for the Philippine Weather Bureau, with a central station in the Manila Observatory, and a series of secondary stations of four classes throughout the Islands, all subject to the Director of the Weather Bureau. Once the instruments arrived in late 1901, the various members of the staff were engaged in setting up the new stations, particularly in the Visayas and Mindanao. At the same time further contacts were made with observatories and stations of China, Japan, Formosa, and Indo-China, whose coordinated efforts made possible quite complete weather coverage of the Orient.[29]

In the early years of the new Weather Bureau, a number of Jesuits, American and English as well as Spanish, were members of the staff in various capacities for a time, but by 1907 the staff which was to be permanent for the next twenty years

[27] Saderra, 139-140; Pastells, III, 424-429.

[28] Pastells, II, 426.

[29] Saderra, pp. 144-151.

or more was at work. Father Miguel Saderra Masó had taken charge of the seismologic and magnetic sections from 1901. Father Juan Comellas returned from studies at Georgetown University Observatory[30] in 1906 to take over the astronomical work, and in 1907 Father José Coronas returned from studies at St. Louis University to take charge of the meteorological section.[31]

While establishing new meteorological stations in 1902, Father Saderra Masó undertook new observations of terrestial magnetism in Mindanao and Jolo, together with Mr. Cesareo Dulueña, first observer of the magnetic section. The latter, incidentally held the record for service to the Observatory, and was perhaps unique in any magnetic observatory, as having done all the absolute measurements, the reduction of observations and calibrations for a period of fifty years, 1891-1941.[32] On his return to Manila, Father Saderra made a comparative study of the results of his observations with those of Fathers Cirera and Juan some ten years earlier. Shortly afterward, however, the magnetic section in the Observatory was rendered inoperative by the new electric street railway in Manila. Consequently a special magnetic station was built at Antipolo where observations began in 1910, to continue uninterruptedly till 1941. When the non-magnetic ship, the *Carnegie*, of the Carnegie Institution of Washington visited Manila in 1912 in its world cruise with its Magnetic Commission, the apparatus of the Antipolo station was found very satisfactory in comparison with the standard of the ship, and the Commission congratulated the Observatory on its installation. The American Coast and Geodetic Survey likewise depended on the Antipolo station for its comparative observations after field trips in the Philippines.[33] However, though the routine ob-

[30] In view of the early relations between the Manila Observatory and the Georgetown University Observatory, it is worthy of note that the present director of the Georgetown University Observatory in Washington is Father Francis J. Heyden, S.J., who first began his astronomical career at the Manila Observatory in 1932--1934.

[31] Saderra, pp. 149, 152, 166-167.

[32] Repetti, pp. 26-27; Saderra, pp. 152-153.

[33] Saderra, pp. 153-155.

servations and their publication continued right down to 1941, there seem to have been no special publications on magnetism in those later years, and since no further modernization of equipment took place in this section to keep pace with the advances in technology, by 1941 it no longer held the high place it had once had.[34] No doubt this was partly due to the fact that Father Saderra was director both of this and of the seismological section, and devoted himself more fully to the latter field, in which his publications were numerous.

The years following 1901 saw a number of further improvements in the seismological section with the installation of various newer types of seismographs. In 1909, on the occasion of the establishment of a new first-class meteorological station in Baguio, seismographs were likewise installed there, which proved valuable in recording the frequent earth-shocks common in that mountainous region. After the terrible destruction and loss of life in the eruption of Taal volcano in 1911, it was decided to establish a seismological station at Ambulong on Lake Taal, with the purpose of giving warning of future eruptions. In 1939 another such station was established on Tagaytay Ridge for the same purpose. In the other secondary meteorological stations of the country, an effort was made to install elementary seismological instruments, inasmuch as funds were unavailable for more perfect ones. However, in Butuan, because of its proximity to the Philippine Deep, and in Guam, likewise near one of the great deeps of the Pacific, important seismographs were installed in 1914 and 1915.[35]

The astronomical section under Father Juan Comellas occupied itself chiefly with the time service, the time being determined by observations of star transits, though he also did some calculations of eclipses of the sun visible in the Philippines.[36] Father Algué's training was largely astronomical, and his invention of a zenith telescope for the determination

[34] Repetti, p. 27.
[35] Saderra, pp. 156-160; Repetti, pp. 28-29.
[36] Repetti, p. 30.

of latitudes has already been mentioned. But on his return to the Philippines he was soon obliged to take over the direction of the Observatory from the failing Father Faura, and thereafter his occupations as Director, particularly with all that this involved in the years of the Revolution and of the reorganization of the Weather Bureau after the change of regime, prevented him from doing the extensive astronomical research for which he had prepared. Certain research on spectometry and other solar research carried on by the German Jesuit Father George Zwack, and the Englishman, Father Robert Brown, likewise never reached completion, due to the return of their authors to their own countries.[37] Father Selga, trained in astronomy like Father Algué, did a certain amount of work on binary stars, and on radial velocities, but his position as assistant director, particularly as Father Algué grew older, drew him more and more into meteorological work. Only Father Charles Deppermann later on would do any substantial amount of a astronomical work, but he too would soon have to re-direct his researches to meteorology on becoming assistant director of the Observatory a few years later. Thus it may be said that though the Observatory never lost interest in astronomy, and particularly on the occasion of eclipses did important observations, due to a variety of circumstances it was never able to carry on a sustained research program in this field in the same way that it did in meteorology and seismology.

In 1924 Father Algué took advantage of the leave he had accumulated to carry out a commission in Rome entrusted to him by his superiors of preparing the Vatican exposition on the missions. While in Spain afterwards he was operated on for his eyes, but the operation was a failure and he remained with less eyesight than before. In view of this he felt unable to continue as Director of the Observatory, and sent in his resignation to Governor-General Leonard Wood. The reluctance with which the latter accepted it was an indication of the great esteem in which Father Algué was held, both in international scientific circles and in the Philippines as

[37] Saderra, pp. 130-131, 167. Repetti, p. 30.

a whole. Another such indication had been the fact that in 1912 he had received the second honorary doctorate ever to be granted by the University of the Philippines, the first recipient having been Cayetano Arellano, Chief Justice of the Philippine Supreme Court.[38]

III. FATHER SELGA AS DIRECTOR, 1926-1945

The successor of Father Algué was Father Miguel Selga, who had returned from his astronomical studies in the United States to become Assistant Director in 1915.[39] In 1921 he was appointed lecturer in meteorology at the University of the Philippines, a position he only relinquished when his appointment as Director of the Observatory made it impossible for him to continue, in 1927.[40] Father Selga seems to have been a highly efficient administrator of the complex organization the Weather Bureau and its network of secondary stations had become. In his continued efforts to improve the efficiency of the service, he was frequently faced with budgetary problems, and had to give considerable time and attention to putting the needs of the Weather Bureau before the Legislature. Such efforts did not always meet with success, but he was not easily discouraged, and persisted in his efforts to get the necessary funds, particularly when it was a question of making more effective the vital typhoon warning service.[41] All these administrative responsibilities were not completely congenial to Father Selga, who would much have preferred to devote this time to scientific work and to the priestly mi-

[38] M. Saderra Masó, S.J., "El Padre José Algué, S.J., Ex-Director del Observatorio de Manila," *Cultura Social* XVIII (1930), 311.

[39] Repetti, p. 30.

[40] For the appointment see: Department of Agriculture and Natural Resources: Weather Bureau. *Annual Report, 1921* (Manila: Bureau of Printing, 1927), part I, p. 9. Father Selga's letter of resignation and its acceptance are in the Observatory Archives, Selga Papers, folder 1, no. 7.

[41] [Charles Deppermann, S.J.], "Father Miguel Selga," *Woodstock Letters* (Woodstock, Maryland, U.S.A.) LXXXVI (1957), 72; Hennessey, p. 112. This was confirmed by some notes of detailed personal recollections kindly given me by Father Bernard Doucette, S.J.

nistry.[42] But once the responsibility was his, he devoted himself fully to it, and not content with merely administering from his office, was often found personally involved on the scene at times of disasters like an earthquake or volcanic eruption, doing his best to quiet people's fears and to encourage those responsible for bringing order and providing remedies in the situation.[43]

In spite of his administrative duties and the personal involvement he gave to his position as Director, Father Selga nonetheless was extraordinarily prolific in his publications. Besides the *Annual Reports*, he produced a continuous series of articles and books on a great range of subjects all during his career. Among these were a number of synthetic studies, summing up the data acquired by the Observatory over a number of years on such matters as the sunshine of Manila, the wind velocity, the rate of evaporation, the temperature, the intensity and amount of rainfall. In addition, he published a number of studies on eclipses of the sun and moon which took place during his period of activity, a volume of studies on Philippine oceanography, a determination of the intensity of gravity for both Manila and Baguio, and numerous other observational studies on various scientific topics, both practical and theoretical.[44]

Accompanying these scientific studies of Father Selga were his historical studies on topics connected with meteorology, seismology, and astronomy. To complement the observational data gathered by the Observatory on these subjects, he utilized his trips to all parts of the Islands on Weather Bureau work to comb the records in old conventos for information on typhoons, earthquakes, volcanic eruptions, and eclipses of

[42] See his remarks in his account of the wartime existence of the Observatory: Miguel Selga, S.J. *Trágico fin del Observatorio de Manila* (Barcelona: Imprenta Revista "Ibérica", 1946), p. 9.

[43] Hennessey, pp. 112-113.

[44] The above summary and that in the following paragraph was made from an examination of the list given by Father Selga in his *The Publications of the Observatory of Manila*, 2nd ed. enlarged (Manila: Bureau of Printing, 1936), and from an examination of those post-1936 publications which the Observatory library has been able to gather after the War.

previous centuries. In Manila, with similar purpose, he searched the old chronicles and histories to be found in the libraries and archives of the religious orders. The fruit of these researches can be seen in a number of the monographs published by the Observatory, as well as in dozens of articles published in Spanish in the *Revista de la Sociedad Astronómica de España y América* and the Jesuit scientific review *Ibérica* from 1917 to 1946. These incursions into the history of science in the Philippines had as their by-product another long series of articles on numerous aspects of Philippine ecclesiastical and civil history. So extensive were these general historical publications, that though his Observatory work never permitted him to publish any book-length contributions to general Philippine history, he certainly ranked high among contemporary historians of the Philippines for the breadth of his knowledge. An indication of this is the large part he played in the work of the Philippine Historical Markers Commission, helping to determine the sites of significance in Philippine history, and composing many of the inscriptions on the historical markers placed in them. The remnants of Father Selga's papers surviving in the Observatory show how frequently he was consulted by such scholars in Philippine history as the late Jaime C. de Veyra and Director Eulogio B. Rodriguez of the National Library.[15]

In the midst of all this administrative, scientific, and historical work, Father Selga found time to devote to spiritual direction, chiefly of students from the University of the Philippines and Philippine Women's University. In the latter institution he acted as spiritual counsellor for over thirty years, and taught religion and lectured once a week from 1919 to the outbreak of the War. His influence was widespread and lasting, as is testified to by the many people who called him to their bedside when they were dying. Philippine Women's Univer-

[15] Though these papers were lost for a long period after the War and have suffered considerable damage, they give considerable evidence of Father Selga's historical activity, both in MS copies of published articles and in notes for projected publications. For an idea of the historical work Father Selga was preparing for publication during the War, see his *Trágico fin,* pp. 9-14.

sity showed its appreciation of him in 1955, conferring on him the honorary degree of Doctor of Science.[46]

In the next few years after Father Selga became permanent Director of the Observatory in 1926, the staff of Jesuits who had worked with Father Algué were gradually forced to retire, due to ill-health and old age. Since in the meantime American Jesuits had taken over from the Spanish Jesuits the responsibility of providing for the work in the Philippines, they were replaced by a group of young American Jesuits just returned from studies in American universities. Father Charles Deppermann succeeded Father Comellas in the astronomical section in 1926; Father William Repetti took over the seismological and magnetic sections from Father Saderra Masó in 1928, though the latter remained as Assistant Director till incapacitated in 1932. When Father Coronas resigned in 1931, he was temporarily replaced by Father Saderra, then by Father Deppermann, who had meanwhile made studies in Norwegian methods at the Geophysical Institute in Bergen and the Meteorological Office in Oslo, becoming the first to introduce Norwegian frontological theory into tropical meteorology. Father Deppermann became Assistant Director in 1932, and was succeeded as chief of the meteorological section in 1933 by Father Bernard Doucette, who had just finished meteorological study at Massachusetts Institute of Technology. Others, such as Father Leo Welch, Father Francis Heyden, and Father Edmund Nuttall took part in the Observatory work for shorter periods, but these men formed the core of the staff up to the War.[47]

Under Father Deppermann considerable improvements were made in the time service, achieving an accuracy of less than one-tenth-second error, thus putting Manila time signals into the First Order grade of the U.S. Hydrographic Office classification. He also made new determinations of the latitude and longitude of the Manila Observatory, published a star atlas adapted to central Philippines, and two lists of variable stars. Also from this period were his studies of the atmospheric elec-

[46] [Deppermann], *Woodstock Letters* LXXXVI, 74-75.
[47] Repetti, pp. 36-37.

tricity of Manila, and of the height of the Heaviside layer, as the ionosphere was called in that early period of its discovery, a foretaste of the ionospheric work of the post-War Observatory.[48]

On becoming Assistant Director in 1932, Father Deppermann devoted all his attention to meteorology, pioneering in the application of the new Norwegian theories of frontal analysis and air-mass theory to Philippine weather and the study of typhoons, on which he produced a series of important monographs in the years 1934-1941. The value of Father Deppermann's work has been recognized by the principal authorities on tropical meteorology in other countries, as witnessed by numerous testimonies.[49] Further indication of this may be found in the translation of so many of his works into Japanese, as well as in the fact that during the War when Father Deppermann was a prisoner of the Japanese at Los Baños, both the Australian Air Force and the U.S. Air Force found his monographs so valuable that each of them republished some of them for their own use in the Pacific.[50] Other testimonies could be reproduced in large numbers, but let it suffice to mention that almost immediately upon his rescue from the Los Baños internment camp by American forces in February 1945, he was called to Washington to attend meetings in the Pentagon for "consultation in connection with weather matters", so highly was his competence valued.[51]

The decade before the War also saw the researches of Father William Repetti on Philippine seismology. While doing his studies at St. Louis University Father Repetti had already discovered a hitherto unknown layer in the earth's crust, hence-

[48] James J. Hennessey, S.J., "Charles E. Deppermann S.J.," *Philippine Studies V* (1957), 314-315.

[49] *Ibid.*, pp. 316-318, 320-321. Father Hennessey reproduces here a number of the citations of Father Deppermann by recognized leaders in the field.

[50] *Ibid., pp.* 318-320. Copies of these reproductions are now in the Manila Observatory Library.

[51] *Ibid.*, p. 311.

forth known as the "Repetti discontinuity".[52] Among his publications in Europe, the United States, and the Philippines, special mention ought to be give to his writings on the epicenters of Philippine earthquakes, and his extensive *Catalogue of Philippine Earthquakes, 1589-1899.* The manuscript of the latter book survived the War by being buried on the Ateneo campus, whence it was resurrected after Liberation and published in the United States in 1946.[53] For this work, Father Repetti, like Father Selga, had combined scientific with historical competence, searching out all references to earthquakes through the old chronicles and histories of the Philippines. In his case too his interest in the seismological history of the Philippines led him into extensive research into the general history of the country, particularly of the work of the Jesuits in the Philippines. Though some of these works were published before the War, unfortunately failing eyesight forced Father Repetti to give up his research after the War, but his work provided the foundation for the recently published definitive study of the Jesuits in the Philippines till 1768, by Father Horacio de la Costa.[54]

In relating the significant events which took place during these years, it is pertinent to recall, as Father Repetti does in his history of the Observatory, that ". . . the routine work of seismology, terrestial magnetism, meteorology, and time service continued without interruption. These daily routine observations are the essential work of such an institution, but they do not make interesting history; the unusual incidents related to them break the monotony. . . ."[55] The numerous

[52] Hennessey, "Manila Observatory," *Philippine Studies* VIII (1960), 113. See William C. Repetti, S.J., *New Values for some of the Discontinuities in the Earth* (Manila Bureau of Printing, 1930).

[53] The entire issue of the *Bulletin of the Seismological Society of America* XXXVI (July 1946), 133-322, is devoted to reproducing the *Catalogue.*

[54] H. de la Costa, S.J., *The Jesuits in the Philippines, 1581-1768* (Cambridge, Mass.: Harvard University Press, 1961), p. vii. The present writer in his own studies of Philippine history at Georgetown University, where Father Repetti is now stationed, has had many occasions to profit by Father Repetti's knowledge of Philippine history.

[55] Repetti, p. 26.

individuals, both those named here and others who for shorter periods devoted themselves to the routine work of the Observatory, were of the highest importance, and indispensable to the work of scientific synthesis manifested in the publications of the Observatory, as well as to the work done on an international plane through the pooling of data obtained from observatories in all parts of the world. In magnetism, for example, though there were no major publications in this field by the Observatory in later years, the hourly data published in the Monthly Bulletin of the Observatory over a period of fifty years were an important contribution, when combined with data from other observatories in other parts of the world, for the understanding of the general phenomenon of terrestial magnetism. The same could be said for the daily seismological and meteorological observations, and for the daily routine work of the time service.

In this connection too, note should be taken of the cooperative and continuous nature of the work of the Observatory. Many of the important publications were the fruit of several men's work over a period of years. Thus Father Algué built on Father Faura's research into typhoons for his own *Cyclones of the Far East*, and his barocyclonometer was a further development of the aneroid barometer of Father Faura. Father Deppermann, in turn, in his work, *Some Characteristics of Philippine Typhoons*, explicitly renounces any intention to supplant Father Algué's classic work, but offers his study to supplement it, adding further data and conclusions which the progress of meteorology has made possible.[56] Father Selga's book, *Observations of Rainfall in the Philippines*, gathers up seventy years of observations, and extends earlier works on the subject from 1907 and 1914 by Father Saderra Masó. Such examples could be multiplied easily.

All this fruitful work came to an end in January 1942 with the occupation of Manila by the Japanese. Cut off from its secondary stations, the weather forecasting work of the Observatory was immediately paralyzed. Soon the Japanese

[56] Deppermann, *Some Characteristics of Philippine Typhoons* (Manila: Bureau of Printing, 1939), p. 5.

attempted to take over the Observatory, but inasmuch as it was private, ecclesiastical property, they were deterred for a time, and attempted to set up a new weather bureau. The Observatory Fathers were kept practically prisoners in their offices, and in 1943 the American Jesuits were carried off to internment camp at Los Baños or Santo Tomás, while Father Selga sought refuge with the Augustinians, and later at La Ignaciana, where he acted as Master of Novices.[57]

In February 1945, as the American forces drew nearer to the city and the Japanese began their work of destruction, soldiers were seen to sprinkle the instruments of the astronomical observatory with gasoline, and a few hours later the whole was a blazing inferno. Some days later the Ateneo was burned with incendiary bombs, and with it perished all the records of eighty years, and the 10,000 volume scientific library of the Observatory, of the greatest value, as well as some 20,000 undistributed copies of Observatory publications. All the principal secondary stations of the Observatory, at Baguio, Antipolo, Butuan, Ambulong, Tagaytay, suffered a similar destruction by one means or another. And in the ashes of the Observatory perished manuscripts containing the fruits of years of work, and notes painstakingly gathered for other publications, belonging to Father Deppermann and Father Selga, most of it work which could never be reconstructed.[58]

IV. THE NEW MANILA OBSERVATORY

When it was seen after the War that the Philippine government proposed to set up a Weather Bureau of its own, for which men had been sent to the United States to study, the question arose as to the future of the Manila Observatory. Though Father Selga's age and failing eyesight made it impossible for him to attempt any revival of the Observatory, Father Deppermann, in spite of discouraging advice from many sides, was anxious to begin again. With the encouragement of his superiors, he planned for a new Observatory in which meteorology would have no part, so as not to duplicate work

[57] Selga, pp. 1-8, 15-19.

[58] *Ibid.*, pp. 20-32; Charles Deppermann, S.J., "The Manila Observatory Rises Again," *Philippine Studies I* (1953), 31-41.

being done by the new Philippine Weather Bureau, and in 1947 went to St. Louis University to brush up on his knowledge of seismology. In spite of persistent ill-health, difficulties over a site, and delays waiting for the necessary funds from the War Damage Commission, Father Deppermann's enthusiasm for the new Observatory never flagged. Finally in mid-1951 he took up temporary residence at Villa Santa Rosa on Quezon Hill in Baguio, while the new Observatory was being constructed on Mirador, the site of the pre-war Observatory Secondary Station. With him were Father Bernard Doucette of the pre-War Observatory, now working in seismology, and Father James J. Hennessey, destined to take charge of the ionospheric research.[59] Even before the permanent residence of the Observatory on Mirador was finished, the seismic vault was completed, and by 1952, after some months of testing, the Observatory began publishing its monthly list of earthquakes recorded. The earthquake recorders were equipped with an alarm system, so that in case any large quake should occur anywhere in the world, the Observatory can send a radiogram to the Warning Center of the Honolulu Observatory, so that warning may be given of the possibility of a tsunami or so-called "tidal wave". At that time Manila Observatory was one of a network of eight seismic stations in the Pacific, of which the only other one in this hemisphere was the government station in Tokyo. Though others have since been added to the system, it still remains a vital link in the Seismic Sea Wave Warning System.[60]

In February 1952 work had already begun in the field of ionospheric research under Father Hennessey, with an ionosonde, or ionospheric recorder, originally loaned to the Observatory on a dollar-a-year basis by the U.S. Bureau of Standards. The ionosonde, operating on a principle similar to radar, bounces high-frequency waves off the electrically charged layers of the atmosphere about 100 and 200-300 kilometers above the surface of the earth, known as the ionosphere. Since

[59] Deppermann, *ibid.*, pp. 33-36.

[60] *Ibid.*, p. 37. For a description of the tsunami warning service, see James J. Hennessey, S.J., "The tsunami of 9 March 1957," *Philippine Studies* V (1957), 211-213.

it is the ionosphere which reflects radio short waves, the nature and varying heights of these layers is of great importance for radio transmission. During the International Geophysical Year of 1957-1958 Father Vicente Marasigan, professor of physics at Berchmans College, Novaliches, did research in the Observatory on the ionosphere, particularly on the so-called F-region, which was later published. Father Marasigan continues to collaborate with the work of the Observatory.[61]

Since the conditions of the ionosphere are known to be affected by conditions on the sun, particularly the activity of sunspots, Father Deppermann planed a program of solar study to be linked with the ionospheric studies. In 1957 Father Richard Miller arrived from his studies in solar physics, and began a program of solar photography as the Observatory's participation in the international program of study of sunspots which formed part of the scientific research program of the International Geophysical Year, 1957-1958.[62]

In late 1956 the state of Father Deppermann's health had become such that he had to be replaced as Director by Father Hennessey, and in May 1957 he died, leaving behind him a life devoted to the service of God through the scientific study of His handiwork.[63] It was under Father Hennessey's direction that the decision was made to transfer the main center of operations of the Observatory back to Manila. Though Baguio offers great advantages for certain types of research, it was felt that the Observatory could both further its own research work and make a greater contribution to the

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[61] Deppermann, *Philippine Studies* I (1953), 38-39; Hennessey, *ibid.* VIII (1960), 118. For a fuller explanation of the ionospheric research, see Hennessey, "Ionospheric Research at the Manila Observatory," *ibid.* III (1955), 164-186.

[62] Hennessey, *ibid.*, VIII (1960), 117-118. For a description of the solar research in the Manila Observatory during the International Geophysical Year, see Richard A. Miller, S.J., "Sunspots and the IGY: the Mechanism of the Sun," *ibid.*, V 1957), 241-260.

[63] Hennessey, *ibid.*, VIII (1960), 118. See also his account of Father Deppermann's career in "Charles E. Deppermann, S.J." *ibid,* V (1957), 311-329; and his bibliography: "The Published Works of Charles E. Deppermann, S.J.," *ibid.*, pp. 330-335.

scientific development of the Philippines by closer contact with a university environment. Its present location on the Loyola Heights campus of the Ateneo de Manila University puts it in easier contact with other scientists of the Ateneo, the University of the Philippines, the Atomic Energy Commission, and other scientific entities in the metropolitan area. Already both its staff and its facilities, particularly its select scientific library, are contributing to scientific work in Manila, without neglecting its basic function as a research institution.[64]

When the transfer of the principal center of the Observatory to Loyola Heights took place in September 1962, the Mirador Observatory in Baguio was not abandoned, but remains as a subsidiary station for seismic and magnetic research. Together with another subsidiary station since established in conjunction with the Ateneo de Davao, under the supervision of Father José Dacanay, it supplements and contributes to the work done in Manila. The ionosphere research station in Baguio was closed, and now operates from a site near the Balara water-works in Quezon City, not far from Loyola Heights.

The present work of the Observatory, already considerably expanded from its Baguio days, falls into two main categories, seismology and sun-earth relationships. The seismological section now possesses three seismic vaults, in Loyola Heights, Baguio, and Davao, the latter two of which have been equipped with complete standardized seismic equipment, and with three stations so spaced, the Observatory is enabled to have results from three widely-separated parts of the Philippines for its research. The Seismic Sea Wave Warning System continues under Father Doucette, while the recent arrival of Father Sergio Su from studies in geophysics will enable the Observatory to broaden its seismology program in the future.

Under the general field of sun-earth relationships might be included the solar studies, ionospheric research, radio physics, and geomagnetic studies. Solar photography continues to be carried on in Baguio, but a spectroheliograph-scope,

[64] Hennessey, *ibid.*, VIII (1960), 119-120.

equipped with a Lyot filter, housed in a separate building at Loyola Heights, makes possible both visual and photographic study of the sun's behavior and its relation to ionospheric and magnetic disturbances. This direct study of solar activity is complemented by the other three fields, in which the activity of the sun is studied indirectly in its effects. The ionospheric research is being carried on by Father Hennessey with greatly improved equipment at Balara, along the same lines as previously in Baguio. In addition, however, the Davao station has recently been equipped with an Air Glow instrument. The phenomenon of air glow, caused by the re-combining of atoms in the ionosphere, is ordinarily invisible, but with this instrument is recorded by means of a photo-electric process. Thus, further information on the strength and condition of the ionosphere complements that gained from the ionosonde. For studies in radio physics, under the direction of Father Francis Glover, who first came to the Observatory as the holder of a Fulbright research grant, the Observatory possesses a number of instruments used for recording such ionospheric phenomena as sudden phase anomaly (SPA), sudden enforcement of atmospherics (SEA), sudden cosmic noise absorption (SCNA), and short-wave fade-outs (SWF). These studies in radio physics which are carried on at Loyola Heights are likewise related to the activity of the sun. Finally, for geomagnetic observations, there are magnetic variometers in both the Baguio and Davao stations, from which records are sent to Loyola Heights on the daily changes in the earth's magnetic field in each place. Since these changes are caused by conditions in the ionosphere, this field in turn complements the other fields of research in sun-earth relationships. Assisting with all these fields of research is Brother Martin Faustino, S.J., who is in charge of the research and development laboratories of the Observatory.

The present scientific work of the Observatory is then, in the broad sense, geophysical. In this may be seen a continuity with the pre-war Observatory, in which astronomical research, for various reasons, never played a great part, but which was devoted to the study of the earth and its atmosphere. Modern investigations have extended geophysical stu-

dies to include the sun, and it is within this scope that the modern Observatory work may be placed. A further continuity of policy in the Observatory is its general limitation of its research to fields in which the Philippines can make a particular contribution, not attainable elsewhere. Thus, though it has men qualified, for example, in quantum mechanics, this can be done as well and better in other parts of the world. But its solar research, for example, carries out observations of the sun's activity at hours when most of the great solar observatories of the world are in darkness. Similarly, the magnetic station of Davao is situated very close to the magnetic equator of the earth, where the earth's magnetic activity has properties not existing elsewhere. No other geophysical station exists this close to the magnetic equator anywhere between America and India, half the circumference of the earth. Likewise the other fields of research of the Observatory provide a uniquely Philippine contribution to the international scientific investigation of the earth, without which the latter would be incomplete.[65]

As the Manila Observatory begins its second century, its energies are directed more towards disinterested basic scientific research, as distinguished from more immediately practical aspects of applied science, than the pre-war Observatory ever was. Even in the pre-war Observatory, however, though the practical needs of weather forecasting and typhoon warnings consumed much of its time and energy for the benefit of the Philippines and of people all through the Orient, it always gave a high place as well to strict research without any immediate practical use in mind. Today when the weather forecasting is competently carried on elsewhere, the Observatory attempts to fulfill a need of today's Philippines, that of the patient, long-range, basic research essential to scientific vitality in any country. In this they stand in the

[65] The writer wishes to express his gratitude for the explanation of the present work of the Manila Observatory graciously given him by Father Hennessey, as well as for the free use of the Observatory Library. Father Bernard Doucette also deserves gratitude for his helpfulness with personal recollections of many points of the pre-war Observatory and the happenings of the War.

center of the Jesuit scientific tradition, studded with names like that of the mathematician Father Christopher Clavius (Clau), the mathematician and astronomer Father Roger Boscovich, the astronomer Father Angelo Secchi, and the paleontologist Father Pierre Teilhard de Chardin, to name only one from each century since the foundation of the Society of Jesus. The universe created by God and redeemed, even in its physical being, by Christ our Lord, is a worthy object for the scientific efforts of men, and part too of the Church's work of sanctification. As priests and religious, these Jesuit scientists work to further man's knowledge and mastery of the physical universe, so that it too may enter into the consummation of Christ's Redemption by man's mind and hands.