Chapter 14

Gioacchino Failla

(1891–1961)

"The thing that I have valued most in life has been friendship. I am happy that I have so many good friends of long standing." (1960)[216]

Gioacchino Failla was born 19 July 1891 in the small community of Castelbuono, Sicily, the son of Sara Spoleti (1875–1958) and Nicolo Failla (1870–1894), a postal worker. When the boy was only three, his father died. His younger sister, Rosina (1894–1897), would soon die as well. His mother decided to join her brothers in their emigration to America, leaving her infant son in the care of his paternal grandfather, Mentor Gioacchino Failla, a practicing physician. Thus, for the next twelve years, it was his grandfather who molded the child's character. Gino's uncle, a noted lepidopterist, and his aunt assumed responsibility for his education, nurtured his powers of observation, and cultivated his aesthetic tastes.

Young Failla studied at a boarding school in the neighboring city of Cefalú, on the Tyrrhenian north coast of Sicily, east of Palermo. The quaint city is dominated by a huge rock (La Rocca) and an ancient Norman cathedral (Il Duomo), from which the community slopes down to the seashore. In these scenic surroundings, Gino had his childhood dreams and formed his adolescent fantasies. There, his innate intelligence was provided with its earliest ideas and the intellectual grounding on which to base his thinking. It was also there that he must have acquired early friendships and affections of which, unfortunately, we know practically nothing (Fig. 14-1).

Making a living as a seamstress under difficult circumstances, it took more than a decade for the young widow, Sara Spoleti Failla, to feel sufficiently established in New York. A deeply religious and abnegate woman, she was determined to bring her only child to live with her. Thus in 1906, when he was fifteen, Gino reluctantly left the ardent country of his birth, his beloved paternal relatives (Fig. 14-2), and his friends to join his mother in New York.

Gino's first task was learning the English language, in which he had no previous preparation but which he intended to learn perfectly. He first registered at P.S. #14 in Manhattan. He asked to be permitted to take only English grammar, and applied himself in earnest. In 1908 he registered at the Stuyvesant Science High School. At the end of his first year, he was allowed to take the examinations of the second year subjects, which he passed successfully. He did well in algebra, drawing, and carpentry, as well as in physiology, German, and French. Living with his mother at 350 East 33rd Street, he felt obligated to add to their income by working part time in a factory producing artificial flowers. He completed the school's curriculum requirements, doing well in trigonometry, physics, and metal foundry works, in all of which he had no language difficulties. He did less well in English and American history.

In 1911, on graduation from the Science High School, he was awarded one of the twelve Pulitzer scholarships ($250 annually for five years) reserved for brilliant but needy graduates of the city's public schools (Fig. 14-3). Although most of the recipients of these scholarships registered at tuition-free City College, young Failla chose to enter the Columbia University School of Engineering. There he excelled in mathematics, physics, metallurgy, mechanical drafting, and mechanical shop, progressing to mathematical physics. He did sufficiently well in all other subjects, and was found deficient only in physical education. He graduated as an electrical engineer (E.E.) in June 1915.

Failla chose to continue his studies and was accepted as a graduate student at Columbia. His subjects included mathematical and experimental physics and radioactivity taught by Professor George

Fig. 14-1. Young Gino Failla around 1905. (Courtesy of Mrs. E.F. Rockhill.)

Braxton Pegram (1876–1953). By then Failla and his mother were living at 549 West 129th Street in Manhattan. No longer on a fellowship, he sought a means of income. In the fall of 1915, Professor Pegram, who admired his mettle, recommended him for a part-time position at the Memorial Hospital in New York. He applied for and gained American citizenship in 1916. At the completion of his second graduate year, he received his master's degree.

In the first decade of this century, thousands of tons of Colorado carnotite were sold and exported to Europe, where the mineral was laboriously processed to extract scant amounts of radium. The market price of the precious metal was over $100,000 per gram. These circumstances were improved by the formation of an improbable triumvirate: James Douglas (1837–1918),[B] a mining engineer and president of the Phelps-Dodge Corporation; Howard Atwood Kelly (1858–1943),[B] professor of gynecology at Johns Hopkins University; and Charles Lathrop Parsons (1867–1954), director of the United States Bureau of Mines. Following a study of ores and locations, the partners bought twenty-seven claims in the Paradox Valley of Colorado, and financed the mining of the raw material and processing in Denver. A steady production of radium became available and was equally divided among the three partners. Kelly's share went to Hopkins. Parsons's went to Harvard and to other institutions around the country. Douglas donated his to the Memorial Hospital of New York, starting in 1914. By 1917, the accumulated amount of radium given to the hospital had reached 3.75 grams, an extraordinary supply for the time period.[341]

Radium bromide in solution emanates gases with short-lived radioactivity, the physical and radiophysiological properties of which were the subject of early study.[107] André Debièrne (1874–1949) of the Radium Institute of Paris had fashioned a means of collecting radioactive gas in sealed glass containers. He and Regaud developed a measure of the radioactivity in millicuries destroyed.[131] William Duane (1872–1935), a former associate of Marie Curie, had perfected a radium emanation extraction and purification plant in use in his laboratory at Harvard.[169] He agreed to install a model of his plant at the Memorial Hospital of New York.[168]

Henry Harrington Janeway (1873–1921)[B] was one of the earliest associates of James Ewing at the Memorial Hospital. A surgeon with unusual ingenuity, he took charge of developing techniques of radiumtherapy and was entrusted with the responsibility of operating the radon plant. For this operation, he needed the technical help of a physicist. This was the

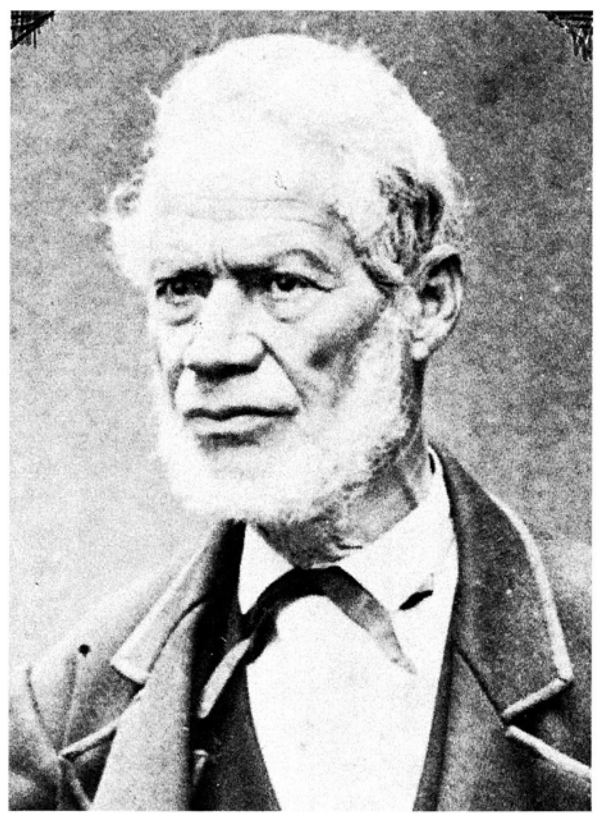


Fig. 14-2. Mentor Gioacchino Failla, M.D., around 1900. (Courtesy of Mrs. E. F. Rockhill.)

part-time position offered to Failla. What might have been just a job to someone else, he turned into the initiation of a remarkable career. He learned to operate the plant, but also learned everything known about radioactivity and its medical uses. He plunged into the subject with zest and, within a short time, became a knowledgeable authority to whom everyone turned for information. He lived his subject, gave it his dedication and, in time, his contributions.

At first, the glass containers of radon were placed in contact with accessible tumors in the same manner as surface applications of radium. Benjamin Stockwell Barringer (1877–1953), urologist at the Memorial Hospital, introduced them through the cystoscope and laid them on the surface of trigonal tumors of the bladder. Janeway provided other surgeons with radon sources for the treatment of malignant tumors of various parts of the body.[341,500]

It became possible to compress radon into capillary glass tubes. John Joly (1867–1933) and Walter Clegg Stevenson (1877–1931) of Dublin were successful in placing the capillary containers into the lumens of ordinary steel injection needles. This not only provided desirable filtration but, in addition, permitted interstitial implantation of the radioactive sources into the tumors.[344,605] Barringer adopted the innovation in order to implant radon into carcinomas of the prostate through the perineum, using local anesthesia.[341] In Paris Regaud advocated the use of hollow platinum needles providing better filtration and more homogeneous irradiation.

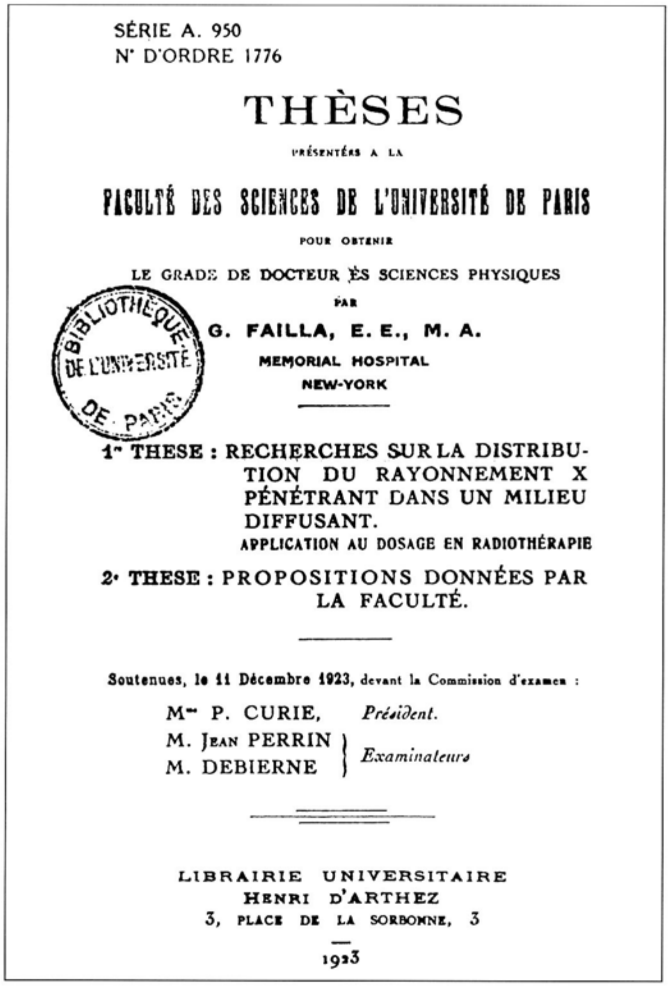
In 1917 Janeway, Barringer, and Failla co-authored *Radium Therapy in Cancer*, a report on early efforts at the Memorial Hospital.[341] The first fifty pages of the book were devoted to a discussion by Failla on the physics of radioactivity. Janeway gave details of his experience with cancer of the skin and oral cavity. Barringer gave results of the irradiation of twenty-five patients with cancer of the bladder and thirty with cancer of the prostate. By means of radon implantation, he succeeded in controlling a few cases of carcinoma of the prostate confined within the capsule.[476] In the process, Barringer also contributed the valuable technique of perineal needle biopsy of the prostate.

Janeway was an impatient and abrasive man who frequently aroused antagonisms among his colleagues, but Failla admired him for his honest dedication to his work and patients, and became very fond of him. In addition to operating the emanation plant and the calibration of its products, Failla took an active part in various approaches and trials with radioactive sources. He developed a machine shop in the basement of the hospital and took delight in the design and construction of all kinds of accessories. His resourcefulness and ability to improvise devices made him much in demand with various workers. Among many other gadgets, he built a bell-shaped lead container to hold radon to be brought into contact with the cervix. The device was employed by Harold Capron Bailey (1878–1929) and William Patrick Healy (1876–1954), the institution's gynecologists.

As the country entered the first World War, Failla was assigned as assistant to the Scientific Attaché of the United States embassy in Rome. After his service there in 1918 and 1919, he returned home via Paris, where he visited the Radium Institute. He met Marie Curie and her associate, Debièrne, who had just resumed their research work. They encouraged him to return and qualify for a doctorate from the University of Paris.

At the insistence of Janeway, the hospital created a department of physics of which Failla was appointed director. In 1919 Edith Hinckley Quimby (1891–1982)[B] was added as his assistant: theirs was a congenial and fruitful collaboration that was to last

Fig. 14-3. Stuyvesant High School graduate, 1911. (Courtesy of Abraham Baumel.)



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THÈSES

PRÉSENTÉES A LA

FACULTÉ DES SCIENCES DE L'UNIVERSITÉ DE PARIS

POUR OBTENIR

LE GRADE DE DOCTEUR ÈS SCIENCES PHYSIQUES

PAR

G. FAILLA, E. E., M. A.
MEMORIAL HOSPITAL
NEW-YORK

1^{re} THESE : RECHERCHES SUR LA DISTRIBUTION DU RAYONNEMENT X PÉNÉTRANT DANS UN MILIEU DIFFUSANT.
APPLICATION AU DOSAGE EN RADIOTHÉRAPIE

2^e THESE : PROPOSITIONS DONNÉES PAR LA FACULTÉ.

Soutenues, le 11 Décembre 1923, devant la Commission d'examen :

M^{me} P. CURIE, *Président.*
M. JEAN PERRIN | *Examinateurs*
M. DEBIERNE |

LIBRAIRIE UNIVERSITAIRE
HENRI D'ARTHEZ
3, PLACE DE LA SORBONNE, 3

1923

Fig. 14-4. Title page of thesis presented at the Sorbonne. (Courtesy of Mme. G. Grais, Bibliothèque Interuniversitaire Scientifique Jussieu, Paris.)

forty years. They complemented each other perfectly, and together were responsible for the logistics of radium and radon at Memorial. In addition, 140 kilovolt roentgentherapy had become available and increasingly in use with its own specific requirements.

M. H. Cesbron, on a mission from France, investigated progress made in radiumtherapy in the United States. He visited Duane's laboratory in Boston, praising his emanation extraction plant.[98] He also visited the Mayo Clinic and other centers in Chicago, Philadelphia, and Baltimore. However, he felt that the work at the Memorial Hospital in New York deserved a special report, for there was "no comparable center anywhere."[79] He praised Failla for his inventiveness and thanked him for his guidance.

An expression of radium dose in milligram-hours, or millicuries destroyed, was called "dose emitted." Failla understood that this was useful when the circumstances of the application could be reproduced exactly. However, for the appraisal of results, only the dose absorbed was important. Based on the law of conservation of energy and his own concept of molecular ionization of tissues, Failla made an elaborate argument in favor of measuring the dose absorbed in calories.[201]

The practice of roentgentherapy (deep therapy) required an understanding of the role of filters, size of fields, distance, etc., as well as a knowledge of the dose delivered at various depths. Failla designed and made a conical ionization chamber connected to a gold leaf electroscope. Carefully avoiding energy leaks, he made extensive studies of the absorption of radiations in tissues.[200] Friedrich Dessauer had contributed isodose curves for use in clinical practice. Walter Friedrich (1883–1968) of Freiburg-im-Bresgau had made a model ionization chamber, and Iser Solomon (1888–1939) of Paris had developed an ionometer. Failla and Quimby made an ionization chamber of bakelite that met Friedrich's requirements. Adopting the use of a water phantom, they proceeded to make elaborate studies establishing depth doses in percentages of skin dose, using various filters and variable distances. They also made charts and tables for practitioners of roentgentherapy.[219]

Anticipating the acceptance of an international unit of roentgen rays and its measurement by means of ionization chambers, Failla made a learned presentation and discussion of ionization, highlighting the essential components of ionization chambers, at the seventh Annual Meeting of the American Radium Society in 1922.[202] Failla and Quimby also undertook an experimental evaluation of filters. Taking it as a given that radiations should be absorbed exponentially in successive layers of tissue, they reached the conclusion (within the constraints of their experiment) that two millimeters of brass, copper, or zinc

Fig. 14-5. Newlyweds Marie and Gino Failla, 1926.

produced the required results with 200 kilovolts (available in 1924). But these results were at the expense of a considerable loss of intensity, which Failla and Quimby considered prohibitive.[218]

Gradually and logically, Failla and Quimby extended their experimental probes beyond the strictly physical. They studied the production of erythema of the skin in laboratory animals and patients, and felt that erythema could be taken as a biologic indicator with some degree of accuracy. This work brought them the award of the Leonard Prize created by the American Roentgen Ray Society in honor of Charles Lester Leonard (1881–1913), distinguished pioneer of and martyr to radiology.[219] With this work, they initiated their fruitful activities in biophysics. Failla embarked on radiobiological experimentation with the utmost care. In a scholarly address, he contrasted the relative ease of physical experimentation with that involving biology. He recognized that the principal difficulty was often the presence of unsuspected variables, requiring careful planning and restraint from premature conclusions.[204]

Janeway had suffered for twenty-one years from an adamantinoma of the mandible, and had treated himself with radium. In 1921 he died of pulmonary tuberculosis. His passing left all concerns with radium and its uses to the department of physics. To this was added the growing responsibility of calibration, dosimetry, and protection in the operation of roentgentherapy.

Failla took a leave of absence and went to Paris to fulfill the requirements of a doctorate. After presentation and defense of his thesis before a tribunal composed of Andre Debierne, Jean Baptiste Perrin (1870–1942), and Marie Curie as chair, he was granted the diploma of Docteur en Science Physiques on 11 December 1923 at the Sorbonne. His was a Diplome d'Etat, usually granted to qualified French citizens only.[203] His dissertation focused on the absorption and dosimetry of X rays (Fig. 14-4).

During Failla's absence, a second report on radium work at the Memorial Hospital was published. With a foreword written by Janeway before his death, the report included a number of new concepts in the radiotherapeutic management of cancer patients. Quimby represented the department of physics as co-author of a chapter on gynecological radiotherapy.[474]

Duane introduced the idea of fragmenting capillary radon tubes into small sections which, with the help of a special trocar, could be buried into tumors. In view of the short half-life of radon (3.8 days), the glass seeds could be retained without significant danger, if not sloughed.[169] Failla designed and built an apparatus which, in a few minutes, could perform uniform segmentation and calibration.[99] Douglas Quick (1891–1966),[B] a Memorial Hospital surgeon, used the bare radon seeds in the treatment of tumors of the upper air passages and on metastatic cervical lymph nodes. Barringer adopted them for implantation in bladder tumors through a suprapubic cystostomy.[472]

Radon seeds became popular in the United States, and were available commercially to physicians. The principal objection to them was their lack of filtration and inhomogeneous irradiation of the affected tissues. Failla verified in laboratory animals the necrotic effects on the tissues adjacent to the source.[213] Heublein and Quick experimented with an absorbable filter surrounding the seeds.[276] Quimby

Fig. 14-6. Failla with daughters Marie Louise (left) and Evelyn Sara, 1936. (Courtesy of Mrs. E.F. Rockhill.)

Fig. 14-7. Newspaper photograph of biophysicist Failla.

made comparative tests of various metals and found that gold was an ideal filter. Failla then developed the procedures for collecting radon in segmented and calibrated capillary gold tubes.[474] These gold seeds were widely adopted and are still in use.

In 1925 Failla went to London as the delegate of the American Physics Society at the first International Congress of Radiology. An agreement was reached there to appoint an International Commission on Units and Measures.

Marie Muller (1901–1936), an art student of German descent, who held a position as hospital secretary, became Failla's wife in 1925 (Fig. 14-5). Failla, his mother, and Marie made their home at 4740 Iselin Avenue in Riverdale, near the Hudson River and Riverdale Yacht Club. Marie played the piano and violin, bringing charm to their home. Their household was soon to be enlivened by the arrival of Marie Louise in 1927 and Evelyn Sara in 1930.

Practitioners of radiotherapy felt an increasing need to relate observed results to the amount of radiation administered. Many thought that a biological unit might be the answer. Based on his own experimental observations, Failla wrote that biological effects depended greatly on the wavelength of radiations, that the various tissues reacted differently to the same amount of radiations, and that the factor time of delivery could not be excluded from the appraisal of effects. Moreover, there was a difference between amounts delivered and amounts absorbed. He concluded that air ionization, within a definable range of variables, was a more logical approach to the establishment of a unit of roentgen ray exposure.[204]

Techniques of brachytherapy using radium and radon had been gradually improved, but did not solve the problems of irradiation of deep-seated large tumors. Various institutions tried to obtain a sufficient amount of radium element to be used for external irradiation at some distance. There was a widely accepted notion that the shorter wavelength of radium would be preferable to 200 kilovolt roentgen rays. However, besides the high cost and insufficient amounts of radium available for telecurietherapy, there was the disadvantage of a relatively large source used at a necessarily short distance. Nevertheless, sources of several grams of radium were put to this use at the Radium Institute of Paris, the Radiumhemmet of Stockholm, and the Memorial Hospital of New York. Failla built a unit to contain four grams of radium, called a pack. It had a turn-off mechanism for protection of personnel, and the source could be used at eight or ten centimeters from the portal. The heavy container was hoisted and mechanically transferred from one room to an adjacent one for fast reuse from 7 a.m. to 11 p.m. James Jay Duffy (1892–1942) was entrusted with the operation of the pack unit.

The roentgen as a unit of x-ray exposure was proposed by the International Commission on Units and Measures and approved by the second International Congress of Radiology in Stockholm under the presidency of Gösta Forssell in July 1928. Forssell had great admiration for Failla and appointed him chairman of one of the Congress's sessions.

Failla's greatest and longest lasting professional preoccupation was undoubtedly with radiation protection. He was particularly concerned with physicians and technologists who handled radium. Over long periods of time, he made careful observations of changes in their skin and nails, and convinced himself that neophytes and careless individuals exposed themselves the most. Failla and Quimby were the first to use dental film as badges for radiation workers, with filters to distinguish between exposures to gamma and beta radiations. Failla made the statement, commonly ignored to this day, that in the concept of dose tolerance, the factor time of exposure cannot be excluded, that a point to be considered is intensity tolerance.[208]

Therapeutic total body irradiation had been tried in earlier days in an attempt to control or palliate generalized tumors. Arthur Christian Heublein (1879–1932), a radiologist from Hartford, Connecticut, with interest in oncologic research, conceived the idea of continuous irradiation of patients, day and night, at a low rate of exposure. He financed the project, and at the Memorial Hospital, Failla built two adjacent rooms with two beds each, contriving their continuous irradiation with two alternate units of 180 kilovolts and 3 milliamperes. The x-ray "bath" consisted of about 300 roentgens in ten days. After Heublein's premature death, Failla gave a report of the project in his honor to the American Society for the Advancement of Science in 1932.

Failla granted exclusive rights to a commercial company to use, distribute, and market his patented inventions. Among these were a vacuum tube with a "floating potential grid," a standard ionization resistance for the measurement of unidirectional electric currents, and a method to arrange the above to provide a differential ionization meter for the evaluation of the quality of radiation.[437] Many of his inventions were never patented.

Experienced radiotherapists, going to extremes of target-skin distance and thickness of filters, had exhausted the clinical potential of two hundred kilovolt radiations in the treatment of cancer. The clamor was for higher voltage units to increase penetration and enlarge the margin of safety between effects on tumors and normal structures. William David Coolidge (1873–1975), who had contributed the hot cathode tube, designed a seven hundred kilovolt unit installed at the Memorial Hospital. Using wheat seedlings, drosophila eggs, and mouse tails as tests, Failla undertook a painstaking comparison of the effects of radiations from the four gram radium pack and those from two hundred and seven hundred kilovolt units. He presented the results of this study to the fourth International Congress of Radiology in Zurich in 1934, which he attended as a representative of the American Radium Society. Supporting the view of clinicians, he concluded that the quality of radiations played an important role in radiotherapy (sub. note 14.1).

A paladin of biophysics, Failla was often sought as a speaker because of the clarity of his presentations. He participated in a symposium, one of many he attended, held in Madison in September 1936 under the sponsorship of the Cancer Institute of the University of Wisconsin. Other speakers included Madge Thurlow Macklin of Western Ontario University, Lew Kleyberg of the University of Oslo, and Henri Coutard of the Radium Institute of the University of Paris (*The Capital Times*, Madison, Wisconsin, 8 Sept. 1936).

Mrs. Failla suffered a streptococcal infection followed by serious renal complications, and died in 1936. A widower at forty-five, Failla took charge of his two daughters, nine and six, and proved to be a devoted and loving father (Fig. 14-6). He employed a full-time governess/housekeeper to take responsibility for their care, and was attentive and concerned with them as they matured and became independent.

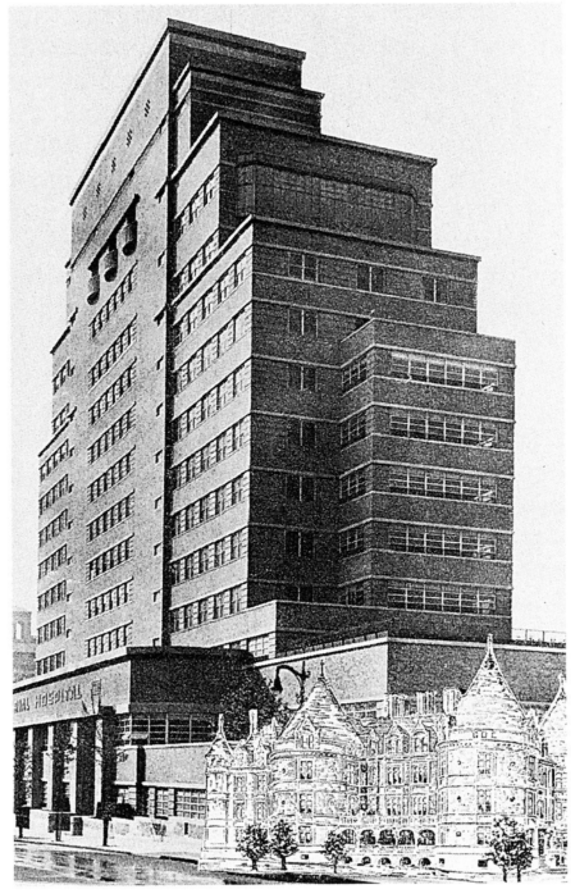

Fig. 14-8. New Memorial Hospital of New York, 1939. Superimposed on the lower right-hand corner is old Memorial Hospital.

The fifth International Congress of Radiology took place in Chicago in 1937. Failla was appointed chairman of the Radiophysics Section. In addition, he became Honorary Chairman of the International Commission of Radiologic Units (ICRU), formed by a battery of international notables, with Lauriston Sale Taylor (1902–) as permanent secretary. Failla wrote a very thorough report presented to both the International Congress and the U.S. government.

In 1938 the Electrical Society of New York elected Failla as its vice-president, and in 1937 the American Radium Society chose him to deliver the Janeway Lecture. On this occasion, Failla took his greatest plunge into the physiopathology of malignant tumors and their radiosensitization. His associate Kanematsu Suguira (1892–1974) had done preliminary work irradiating sarcoma *in vitro* and implanted *in vivo*.[480] Failla observed that irradiated tumor cells often swelled before dying. He assumed that this was caused by a disturbance of the osmotic pressure, possibly due to ionization affecting the cellular membrane. Failla and Sugiura also observed that tumors irradiated *in vitro* and then placed in a hypertonic solution yielded the highest rate of successful implants, leading them to the interpretation that the medium could influence the results of irradiation. They then injected distilled water into the irradiated tumors and found that this resulted in considerable increase in total regressions. Failla took care to state that whatever conclusions were drawn from these observations should be considered tentative and only as a basis for further research. However, this work, together with a contemporary report to the National Academy of Sciences on high velocity injection, captured the imagination of newspaper reporters ("a water cure for cancer"). The unprecedented publicity in hundreds of newspapers aroused hopes of better clinical results (Fig. 14-7).[210]

In June 1939 the Memorial Hospital of New York moved to a new twelve-story building at 400 East 68th Street, the gift of John D. Rockefeller, Jr. (Fig. 14-8). The transfer of the four gram radium pack was made in a truck with Failla as a passenger and with police protection. The moving of the additional four grams into the emanation plant required contracting with an out-of-state expert. On Ewing's retirement in 1940, the institution was directed by Cornelius P. Rhoads (1870–1959), who was primarily interested in laboratory research. As for clinical radiotherapy, the medical staff adhered to the concept acquired in the early years: surgeons of the various divisions were the arbiters of its use. Surgeons applied radium in the operating room, and prescribed the courses of roentgentherapy carried out by their residents. The institution had no radiotherapist. It took Rhoads several years to appoint one with even limited attributions. Meanwhile, the responsibility for equipment, technical personnel, and the logistics of roentgentherapy, in general, were Failla's.

During the second World War, Failla became a consultant to the Manhattan Engineering Project and to the Metallurgical Laboratory in Chicago. The Failla family spent the summers in Woods Hole, Massachusetts, while he worked at the Marine Biological Laboratory. There he installed a dual tube high intensity x-ray unit.

On 31 December 1942 Failla resigned from the position he had held for twenty-seven years at the Memorial Hospital. He remained only as a consultant. A farewell dinner was attended by over one hun-

Fig. 14-9. Newlyweds Pat and Gino Failla, 1949. (Courtesy of Patricia Failla, Ph.D.)

dred colleagues from the Memorial Hospital staff, with speeches by Rhoads and Lloyd Freeman Craver (1892–1979). Columbia University announced the establishment of a new Laboratory of Radiological Research with Failla as its director and as professor of radiology (physics) at the College of Physicians and Surgeons. With him went Quimby and Titus Carr Evans (1907–1975) as his associates in the work of the new laboratories. It was originally expected that their work would be related to the Florence Nightingale Hospital being built at 163rd Street and Washington Avenue. However, the construction was temporarily halted by the war. When later resumed, the name was changed to the Francis Delafield Hospital.

The American Roentgen Ray Society asked Failla to deliver its 1945 Caldwell Lecture. It was most appropriate for him to speak in memory of Eugene Wilson Caldwell (1870–1918),[B] an electrical engineer who became a physician and made seminal contributions to radiology before dying a victim of radiation exposure. The Society canceled its annual meeting because of the war, but the text of the lecture was published in full.[211] Failla emphasized the fact that there were then a greater number of supervoltage units operating in industry than in hospitals, and that the numerous and varied modalities of their use made it difficult to appraise rates and limits of safe exposure. The accepted tolerance dose for medical exposure was then one hundred milliroentgens per day, but he felt that higher standards would require further reduction.

The Radiological Society of North America awarded its gold medal to Failla in 1945. In 1949 the University of Rochester (New York) conferred on Failla the degree of Doctor of Science *honoris causa*. He was a consultant to the Public Health Services and Veterans Administration. A variety of institutions and committees, particularly those involved in atomic research, sought him for his expertise in radiation protection. He was also a consultant to the Argonne National Laboratories, Los Alamos Scientific Laboratories, and to the Nuclear Engine Propulsion Aircraft Project. He was Chief of the Biophysics Branch, Division of Biology, of the Atomic Energy Commission. He was also a member of the National Defense Research Committee of the Radiobiology Panel, Committee on Growth, of the National Research Council. As an executive of the National Committee on Radiation Protection from 1946 to 1957, he carried exceptional weight in establishing standards of permissible exposure. He was also chairman of the Radiological Instruments Panel of the Armed Forces Special Weapons Project and chairman of the Genetics Committee of the National Academy of Sciences. Although not simultaneously, he gave each of these positions considerable time and attention, as testified to by the voluminous correspondence held in his files over the years, now in the Center for the American History of Radiology in Reston, Virginia.

A man with so many professional commitments might be expected to disregard his family obligations, but Failla was very attentive to the needs of his daughters. Mary Lou studied biology at Swarthmore College, and took a job at the Lerner Marine Laboratories in Bimini. Failla corresponded with and advised her. She also worked at the Museum of Natural History in New York. He had frequent exchanges with the headmistress of St. Mary's Hall in Burling-

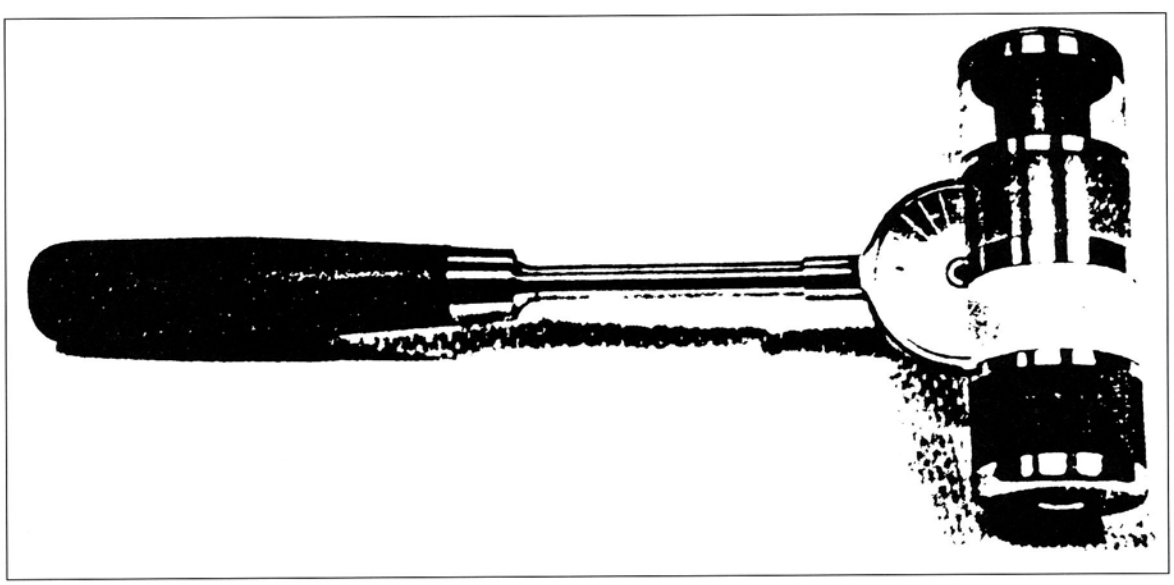

Fig. 14-10. Gavel constructed by Failla and given to the Radiation Research Society.

ton, New Jersey, in reference to the progress of Evelyn, who later attended Mount Holyoke and Barnard Colleges. His daughters returned his affection.

In 1947, Patricia McClement, a recent Barnard College *cum laude* graduate, was doing pre-doctoral work in the physics laboratory of Carl Bjorn Braestrup (1897–1982), in a facility adjacent to Failla's laboratory. She asked Failla for advice on continuing her graduate work. He encouraged her to write her thesis in the field of health physics. For consideration by the faculty he stated that he had observed her for two years, and that she had shown analytical ability and originality as well as exceptional resourcefulness. He indicated that he would be glad to supervise the progress of her graduate work and thesis. A year later, however, on receiving a request for a progress report, he replied that he could not do so because Miss McClement was now his wife. He suggested Professor Shirley Leon Quimby (1893–1986) of the university's department of physics, who was her supervisor. On 22 January 1949, following twelve years of widowhood, Failla had married Patricia McClement. She joined the family at Riverdale and was like a sister to her stepdaughters, one of whom, Evelyn, was shortly to become Mrs. Robert Kent Rockhill. They all had a very affectionate relationship. In the laboratory, Patricia became Failla's partner and a happy companion in his travels (Fig. 14-9).

The rapid adoption of radioisotopes in research laboratories, operating rooms, and departments of medicine put a great number of workers at risk and created new problems of radiation protection. Many of these workers could not be expected to understand radiobiology, and Failla knew by experience that guidelines were likely to be ignored by neophytes. The permissible dose for total body exposure had been reduced to three hundred milliroentgens a week and, for exposure of hands, to fifteen hundred milliroentgens per week.[212]

The Roosevelt Hospital of New York obtained a loan of fifty grams of radium, then worth over a million dollars, from the Belgian Union Miniere. It was intended for telecurietherapy use by Douglas Quick, director of the hospital's department of radiotherapy. The problems of such a project were those of providing housing for the source which could facilitate its clinical use while at the same time providing protection for the personnel. Failla designed a unit with a special collimator and a mechanism to reduce exposure of personnel between treatments *(New York Times,* 14 December 1950).

The long discontinued International Congresses of Radiology were resumed in London in 1950. Failla and his wife attended the sixth Congress, of which he was honorary vice-president. On that occasion, he was also a guest of the Radiotherapists Visiting Club at their meeting in Oxford, and became an honorary member of the British Institute of Radiology. He was again honorary vice-president at subsequent congresses held in Copenhagen (1953) and Mexico City (1956).

There had been talk in the American Physics Society of creating a division of biophysics. Failla felt very strongly that radiation research involved disciplines so disparate that they could not be gathered into any existing society. In May 1950 he circulated a letter suggesting the creation of a new society in which physicists, chemists, biologists, and medical scientists could meet each other as equals in their interest in radiation research. Shortly afterward, the suggestion was discussed at a symposium at Oberlin College. An organizing committee with Failla as chairman was elected. The committee proceeded to prepare the constitution and by-laws of the Radiation Research Society, mailed ballots for the election of the first officers, and legally incorporated the society in the District of Columbia in March 1952. The first meeting took place in Iowa City in June 1953.

Failla was also an important force behind the creation of a journal of radiation research, with Titus Evans as managing editor. He was elected president of the nascent society. In his presidential address, he described the gavel which he himself had constructed and was donating as a gift. The head consisted of four sections: lucite for physics, a synthetic plastic for chemistry, ivory for biology, and lignum vitae for medicine. He pointed out whimsically that the four parts were equal in size, though not in weight. The lucite chamber is hollow, containing glass and plastic beads of opposite charge. As the chairman uses the gavel, all beads cling together, as all society members should (Fig. 14-10).[215]

The term "health physics" originated at the Metallurgical Laboratory of the University of Chicago. It had become necessary to designate those physicists involved with radiation measurements and protection of radiation workers as distinguished from theoretical physicists or those concerned with other aspects of physical science. Failla used the term in the early 1940s. A Health Physics Society was founded in 1956. Although Failla did not participate in its formation, nor was he an officer, he gave it his moral support. "Truly, he was one of the earliest and greatest health physicists," wrote Walter Stephen Snyder (1909–1977).[572]

In 1957 Patricia and Gioacchino took a pleasantly long voyage to Naples, Italy, where he was a vice-president of an atomic symposium at Il Matino in Naples, 27 September 1957. They took time out to visit Sicily and drove through Castelbuono and Cefalù, the towns of his childhood. On their return, Mrs.

Fig. 14-11. Gioacchino Failla, E.E., Ph.D., Emeritus Professor of Radiology (Physics), 1960. (Courtesy of H. Howell, Curator of Columbiana.)

Failla presented her dissertation and was awarded a Ph.D. by Columbia University. Her subject was the measurement of dose in small tissue volumes surrounding radioactive point sources.

Significantly, Failla's last published papers were concerned with the subject of aging. He opened his discussions on this subject in a paper presented to the Radiological Society of North America under what he admitted was a misleading title in December 1953. He postulated that although daily exposure to radiation could be reduced, the accumulated total exposure was also important, and that although recovery was greater than irreversible injury in general, the reverse was true for highly specific ionization such as that of alpha particles and neutrons, for they produce chromosome damage and somatic gene mutations. He further theorized that if the aging process is due to the accumulation of mutated cells in all tissues of the body from various causes (heat, childhood diseases, heredity), then exposure to ionizing radiations simply increases the mutation rate and accelerates the aging process.[213] Failla also presented these views to the New York Academy of Sciences.[214] He elaborated this theme further in a paper co-authored by Patricia Failla which they presented to the 1957 annual meeting of the American Roentgen Ray Society. Here it was revealed that the Committee on Radiation Protection now recommended a maximum accumulated exposure of fifty roentgens in ten years. According to their calculations, the shortening of life caused by such exposure would be eight months.[217]

Mary Louise Failla had become Mrs. James Denis Campbell. Aged Mrs. Sara Spoleti Failla spent the last year and a half of her life in a nursing home and died in 1958, at age eighty-three.

Failla's laboratory force already consisted of some thirty busy workers doing independent work, among whom Katherine Robinson (Mrs. Arnold Johanny) served as both secretary and guiding spirit. Failla had reached the academic retirement age. His associates and friends offered him a festive tribute dinner at the Columbia University Faculty Club on 23 April 1960. A poem was offered to "the Chief" by Mary Twombly ("your friends are gathering here tonight, to bring you honor and delight"). Drs. Lloyd Craver, Ross Golden, Paul Henshaw, Robert Rugh, and Leo Marinelli shared their reminiscences. Harold Rossi, Failla's successor as director of the laboratories, offered a tribute, which said in part: "Creative activity of such breadth and depth requires not only a curious, brilliant and inventive mind that increasingly explores new and more advanced frontiers ... but also superb character and temperament: unflinching acceptance of the truth is as ingrained in Failla's approach to science as is his uncompromising justice in human relations."

Failla closed the event with an extemporaneous account in which he revealed details of his childhood which his daughters, who were present, had never heard before. In a letter of thanks written later to all those present, he said that what he had valued most in life was friendship, and added that he wished to grow older gracefully. On 1 July 1960 he became professor emeritus of radiology (Fig. 14-11). He then pondered leaving the city that had been his home for half a century and moving away from his daughters and five grandchildren.

Failla was offered a position as senior physicist emeritus by the Argonne National Laboratories where his former student and associate, John E. Rose, was head of the radiological physics division. Dr. Patricia Failla was appointed associate scientist. Thus, the Faillas moved to Chicago and went to live at 575 Warren Terrace in suburban Hinsdale. He was given a dinner on the occasion of his seventieth birthday. He was elected honorary member at the annual meeting of the Radiological Society of North America in Chicago late in November 1961, where he declared that he expected to continue to work for several years. Alas, fifteen days later, as Failla was driven to work by John Rose in the early winter morning of 15 December 1961, there was a head-on collision on icy roads in the community of Downers Grove. Rose was seriously injured; Failla died instantly.

Attempts made to compile a list of Failla's original contributions have often failed for several reasons. Many of his technological contributions he did not think worthy of a patent, and so came unheralded into general use. Many others were ingenious improvements of the work of others, and it is often difficult to ascertain which parts of them are to be credited to him for their usefulness. He was not the only one to publish his ideas: they were freely given to his collaborators and friends. Those who associated with him, wrote Harold Rossi, incurred the truest of debts, nobly granted and received in the knowledge that they could never be repaid.[540]

Always well attired, close shaven, wearing a necktie even when working in the shop or in his garden, Failla was a man of medium height and fair complexion, dark brown eyes, and curly dark hair that receded slightly, becoming slowly gray. Nothing in his appearance, demeanor, or preferences suggested his Italian origin; only his name did. He had a serious countenance that hid a great sense of humor and restrained sentimentality. He listened intently with fixed eyes. He was an indefatigable worker. Louis Harold Gray (1905–1965) told of one occasion when, because of the illness of the responsible member, the ICRP report was not prepared. Failla filled several suitcases with documents and spent days of his vacation preparing the Commission's draft.[281] His versatility and originality found expression in the design and construction of all kinds of devices. It was an aesthetic delight, wrote L.H. Gray, to contemplate his inventiveness and the subtlety of thought that characterized his experiments.[251] He bore extracurricular activities with equanimity and sometimes with gusto, wrote Leonidas Donato Marinelli (1904–1974).[176] His personality was such as to make others like and respect him, said Harold Rossi.[540] His probity, righteousness, and generosity became proverbial. Thousands of radiation workers of several generations owe much to his work on radiation protections.

Subject Notes

14.1 In 1935, returning to France from a visit to my father in Cuba, I stopped in New York to present my respects to Dr. Ewing, and he kindly presented me to his younger associate, Fred Stewart (1897–). I was introduced by Stewart to the developing technique of aspiration biopsy: the aspirated material was smeared on a slide, stained, and microscopically examined for cytological diagnosis of malignancy. I also visited Failla and Quimby. I was invited to dinner at Failla's home in Riverdale in the company of Hayes Martin (1892–1927), James J. Duffy, and other members of the clinical staff. After dinner we adjourned to the back yard, where we talked late into the night and could see only each other's lit cigarettes. The bone of contention was the clinicians' persistent demands for Failla, who was the technological arbiter, to allow heavier filtration in order to improve their results of roentgentherapy to equal those of Coutard in Paris. I had been brought to provide inside information on the work at the Fondation Curie. Failla considered the filtration of 2mm of copper for 180kv used by Coutard to be excessive and was adamant that the better results were due to painstaking daily observation of the mucous membrane and skin reactions during the fractionated long treatments, as well as to the adaptation of daily dosage by clinical judgment. Failla was right.