1993–1994 patents. For research papers in physics, NSF support is cited most often and the Navy is second, followed by the Department of Energy, the Air Force, DARPA, the Army, NASA, and DOD in general.

This "strong reliance of U.S. industry patents on public sector science," the paper remarks, "implies that U.S. industry is far from self-sufficient in science." It concludes "that public science plays an essential role in supporting U.S. industry, across all the science-linked areas of industry, amongst companies large and small, and is a fundamental pillar of the advance of U.S. technology." The study will be available from CHI Research, Inc., 10 Whitehorse Pike, Haddon Heights, NJ 08035; tel. 609-546-0600; fax 609-546-9633; e-mail 73302.1036@compuserve.com.

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Baron Marcel Nicolet (1912–1996)

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Marcel Nicolet, honorary founder and director of the Institut d'Aéronomie Spatiale de Belgique, passed away on October 8, 1996. Born in the village of Basse Bodeux, Belgium, on February 26, 1912, Nicolet completed his studies in Greek and Latin Classics and went to the University of Liège to study philology. After a few months, he switched courses and registered as a student at the Faculty of Sciences, where he obtained a degree in physics in 1934 after writing a dissertation on the spectrum of O and B stars. He published this work with Paul Swings in the *Astrophysical Journal*.

Nicolet was soon noticed by Jules Jaumotte, director of the Institut Royal Météorologique (IRM) in Uccle, and he became a staff member of the institution in 1935. He liked to recall that new arrivals started off in the weather office, as he did. Nicolet split his days between Uccle and the meteorological office in Haeren, where he worked for the national airport weather forecast, while preparing a doctoral thesis under the direction of P. Swings in Liège. His thesis, "Study of the Spectrum and Composition of Stellar Atmospheres," was presented in 1937. In March of the same year, he spent his first mission abroad, at the Swiss Lichklimatisches Observatorium in Arosa, where Götz was observing the atmospheric ozone in collaboration with Gordon Dobson, who was at Oxford. Observations of night airglow were also undertaken there, in which Nicolet participated. Now married, he returned to Arosa from October 1938 to March 1939, accompanied by Alice.

By then, Nicolet had authored 28 scientific publications, eight of them with other writers. His publications focused on the atomic and molecular composition of stars, the Sun in particular, and also comets and the Earth's upper atmosphere. Over the course of his long career, he authored more than 200 publications, particularly in aeronomy but also in meteorology and astrophysics, and they all bore the mark of his extremely rigorous scientific approach. He also published two books, *Aeronomy* (Mir publishers, Moscow, 1964) and *Study on the Chemical Reactions of Ozone in the Stratosphere* (Institut Royal Météorologique, 1977).

Nicolet had just been charged with creating an infrastructure for radiation observations in Uccle when war broke out. The members of the IRM scientific staff were mobilized at the Belgian Army Headquarters, and they lived through the last hours of the 18-day campaign of the German invasion in May 1940 at the Belgian coast, which marked the beginning of World War II. Nicolet used to enjoy recounting the episodes experienced with his friend, Jacques Van Mieghem, who later became Director of the IRM.

Marcel Nicolet (left) with Senator Lyndon B. Johnson at a space symposium on upper atmosphere and medicine in November 1958.

When he returned to Uccle, Nicolet and his colleagues were placed under the authority of the German occupying forces, a representative of which was present to ensure that orders were obeyed. They were forbidden to forecast the weather. Nicolet continued his study of the Sun and the upper atmosphere and was able to present an agrégation thesis, "Contribution to the Study of the Ionosphere," to the University of Brussels in 1945. Nicolet's thesis explained how the ionospheric D region forms on purely theoretical and speculative bases. He postulated that solar radiation at the wavelength of the Lyman alpha line of hydrogen could penetrate the mesosphere, leading to ionization of nitric oxide. For this, he imagined an optical window in the oxygen absorption spectrum and NO formation processes.

This work, subsequently translated into English by NASA, brought him international acclaim and invitations to numerous conferences, as well as an invitation from Frank Roach, a specialist in airglow, to spend January–June 1950 at the California Institute of Technology. At this time, the Aden and Marjorie Meinel husband and wife team had just observed the nocturnal spectrum of the OH molecule identified by Herzberg, and ozone observations by the Naval Research Laboratory via rocket-borne spectrometers had just demonstrated a deficit of mesospheric ozone that disagreed with the theory formulated by Chapman in 1930. At Caltech, Nicolet met another European invited by Roach: Sir David Bates, mathematician and pupil of Sir Harry Massey, and therefore a specialist in the theory of atomic and molecular collisions. Bates and Nicolet became close friends and pooled their knowledge to explain the reduction in the mesospheric ozone by catalytic reactions involving HO_x. Their results were subsequently transposed to the stratosphere for NO_x by Paul Crutzen in 1970 and by Richard Stolarski and Ralph Cicerone for ClO_x in 1973, and finally made widely available by Sherwood Rowland and Mario Molina in 1975.

Nicolet was ennobled by the king of Belgium in 1986. His coat of arms bears a globe with circles of longitude and latitude. A satellite in orbit surrounds the globe.

In May 1950, some 20 scientists, mainly American but also including Sidney Chapman, who had left Oxford for the University of Alaska, and Nicolet discussed Lloyd Berkner's suggestion of repeating the International Polar Years every 25 years rather than every 50 years. This meeting took place at the Naval Ordnance Test Station at Inyokern, China

Lake, in California. The question was debated again at the Conference on the Physics of the Ionosphere, which was hosted by the Ionospheric Laboratory of Pennsylvania State University at the invitation of its director, A. Waynick. Waynick invited Nicolet to be research professor at the Ionospheric Research Laboratory, where he subsequently supervised several doctoral students. The official proposal for a third Polar Year was put to the International Council of Scientific Unions via the Joint Commission (geophysics and astronomy) on the Ionosphere meeting in Brussels in 1950.

The decision was made to hold the third International Polar Year, which was to be titled "International Geophysical Year." To organize the event, the International Council of Scientific Unions set up the Special Committee for the International Geophysical Year (CSAGI), whose bureau was chaired by Sidney Chapman with the American Llyod Berkner, the Russian Vladimir Beloussov, and the Frenchman Jean Coulomb as members and Nicolet as secretary general. At the time, Chapman was president of the Association of Terrestrial Magnetism and Electricity, whose title he had changed to the International Association of Geomagnetism and Aeronomy. The word aeronomy was a new one and first appeared during the presidency of his successor, Coulomb.

Meetings of the 14 disciplines of the CSAGI were held in Brussels, Moscow, and Barcelona. The proposal to launch artificial satellites into orbit around the Earth was officially made in Rome in 1954, with a view to extensive observations of solar and terrestrial phenomena. Though mentioned rarely, the role that these scientists played in the advent of the space age was decisive.

International Geophysical Year 1957–1958 was an unprecedented scientific success. The Sun was going through a particularly active period, the first Sputnik was launched, and 67 countries participated on a nongovernmental basis through the initiative of scientists, largely due to the competence and motivation of Nicolet. What made it possible was Nicolet's intelligence, his farsightedness, his outstanding tact, his dedication, and his exceptional appetite for work within the propitious setting of the Institut Météorologique, where his zeal and enthusiasm earned him the lasting devotion of his colleagues.

The International Geophysical Year, during which the first artificial satellites were launched, had lasting effects all over the world. For example, the instruments installed at Halley Bay in Antarctica by Dobson in 1957 led to the discovery of the spring reductions in the ozone layer that were published in 1985. Many installations became permanent, and scientific institutions were formed that specialized in studies and research by means of space vehicles. In Belgium, a group of scientists at the Observatoire and the Institut Météorologique, together with members of several universities, created the Centre National de Recherches de l'Espace, of which Nicolet was naturally made director.

Pursuing his scientific work, Nicolet was the first to explain the braking effect of the atmosphere on the first satellites. He was acknowledged for this scientific milestone by the the United Nations in 1960. This work, for which he had laid the foundations in 1938, was to win him the Daniel and Florence Guggenheim prize of the International Academy of Astronautics in 1963, given for his discoveries in astronautics over the previous 5 years. He obtained this distinction after Van Allen, who received it for discovering the radiation belts around the Earth. The highest authorities consulted Nicolet in Belgium, as when President Kennedy was assassinated and replaced by Vice-President Johnson, senator of Texas and champion of space exploration whom Nicolet had met.

The Institut d'Aéronomie Spatiale de Belgique was established in December 1964 at the request of King Baudouin and on the instructions of Prime Minister Theo Lefèvre. Due, in part, to his wide repute, Nicolet was named its first director. His friend and colleague Jacques Van Mieghem, director of the IRM, set aside part of the climatological park for buildings on which construction began in 1970. The multidisciplinary nature of the staff, on which Nicolet insisted, was a direct consequence of his international experience in scientific institutions around the world. He saw success resulting from collaboration.

In 1965, Nicolet received the Hodgkins Medal from the Smithsonian Institution for his work in the field of aeronomy. In 1970, he attended an international meeting organized by the Massachusetts Institute of Technology on the problem of global pollution of the stratosphere. From 1971 to 1975, at the request of the French Ministry of Transport, Nicolet formed part of the scientific committee set up under the aegis of the French Academy to study stratospheric aircraft flights. Nitric oxides produced by the aircraft engines threatened to potentially destroy the ozone layer.

Nicolet's assistance was also sought by the U.S. Department of Transportation. His work had led him to predict the presence of NO, NO_2, and HNO_3 in the middle atmosphere. His knowledge on this subject was unique. While Nicolet was president of the International Association of Geomagnetism and Aeronomy (1959–1963), he introduced the leading international minds in gas phase chemistry and photochemistry to the secrets of aeronomy.

Nicolet retired in 1977, but continued his scientific work on the Sun's ultraviolet radiation, especially with Lucien Bossy, and on stratospheric chemistry. His unselfish spirit of cooperation won him the Bowie Medal, the highest distinction of the American Geophysical Union, for his role in determining photodissociation and photoionization in the atmosphere, predicting the presence of a helium belt around the Earth, and the presence of NO, NO_2, HNO_3, HO_2, and H_2O_2 in the atmosphere before any observations were made.

King Baudouin ennobled Nicolet in 1986. He was surprised by this attention, yet it made him very happy because his constant wish was to be a loyal servant to Belgium. As Belgium's present Minister for Science Policy, Yvan Ylieff, remarked recently : "Thanks to the action of Marcel Nicolet, the contribution made by Belgian researchers has attained an importance and a quality much higher than could have been expected of a small country, and this in a field that is recognized today as essential for the future of our planet."

It must be recalled too that Nicolet also taught at the Universities of Liège and Brussels, and served as a corresponding member of the scientific academies of the United States and France, as well as a member of the Académie Royale des Sciences, des Lettres et des Beaux Arts of Belgium, of which he was science class director. He was chairman of four national committees: the Committee for Space Research, the Committee of the International Union of Geodesy and Geophysics, the Committee of the International Union of Radio Science, and the Committee for International Geophysical Cooperation.

Nicolet's wife, Alice, was the focus of his life. She accompanied him on all of his major trips, and they were very devoted to each other. There were no children, and for most of his life he would take lunch with her at home. She provided him with a most gentle, pleasant home environment, which was always a private retreat for him.

The scientific journey, or more precisely the numerous scientific journeys interwoven by Nicolet, must be a subject for reflection by all those concerned with the development of scientific knowledge in general and modern science in particular. All those—and there are many of them—who witnessed his intellectual approach, who delighted in his lively mind and farsightedness, and benefited from his advice and teaching, were very lucky indeed and owe him permanent recognition.—*Baron Marcel Ackerman, Institut D'Aeronomie Spatiale de Belgique, Bruxelles, Belgium*