Cathleen S. Morawetz was born in Canada and earned a bachelor's degree from the University of Toronto, a master's from MIT, and a Ph.D. in 1951 from New York University, where she was a student of K. O. Freidrichs. She joined the NYU faculty as a research associate in 1952, then rose through the ranks to become a professor. She served as director of its Courant Institute from 1984 to 1988. Her research has focused on the applications of partial differential equations, especially on problems of transonic flow and scattering theory. She is the daughter of the Irish mathematician John L. Synge. Her hobbies are sailing in Canada and entertaining her four grandsons.

The Courant Institute of Mathematical Sciences

CATHLEEN S. MORAWETZ

One of the measures of the blossoming and maturing of mathematics in America since the conclusion of the Second World War is the rise to eminence of a large number of departments of mathematics. Before the war, mathematics in America was largely shaped by what went on at Harvard, Chicago, Princeton, and the Institute for Advanced Study; since the war one has had to reckon with research carried on at Yale, Illinois, Michigan, Wisconsin, Berkeley, Stanford, Maryland, to mention just a few of a happily growing list. Among these newly minted centers stands the Courant Institute; its birth was a most improbable event, since at its inception its parent institute, New York University, lacked financial resources, and was without a tradition of excellence in the sciences; it was the most unusual among the new centers, for it took — and still takes — as its agenda the mathematics inspired by applications. It was the creation of Richard Courant, a practical visionary, who held a large view of mathematics, not just as an art for art's sake but also as a vital way of making sense of the world. His story and the influence his Institute had — and has — on American mathematics is worth telling in this Centennial Year.

The origins of the Courant Institute go back to 1933, when Richard Courant was forced under the Nazi laws, from his position as director of the renowned Institute of Mathematics at Göttingen. In 1934 he was offered a position at New York University which he accepted with some reluctance since NYU was

by no means at that time an institution of quality. In 1935, after one year in New York, that position was made permanent and he became the head of a graduate department of mathematics. He had observed on a visit to America in 1932 the low esteem in which mathematics was generally held at the larger universities and he wanted to change that, at least at NYU. Initially the only colleague at NYU who sympathized with this desire was Donald Flanders. In fact it was Flanders who had initiated through Veblen the first approach to Courant by NYU.

Courant's acceptance of the offer from NYU was influenced by two factors: the difficulty he had in helping others to find mathematical jobs in America and the opportunity to develop, in Abraham Flexner's words to Courant, "the great reservoir of talent" that lay in New York.

Courant's initial struggles were for space and positions at NYU but by fall 1938 he had achieved only a little: positions for Kurt O. Friedrichs and James J. Stoker, some fellowships, and some offices carved out of the girls' dormitory at NYU. But despite the odds against him, Courant worked on. Seeing World War II looming ahead with a great demand for science, he put forward a plan for a national institute of science but it failed in the scientific community, and Courant concentrated on his own vision of an institute at New York University.

From 1940 to 1945 the American scientific community was first preparing for and then working for the war effort. As Courant himself said years later, the god Mars helped his fledgling endeavor. Funds from the Office of Scientific Research and Development made it possible for Courant to expand his little group and to undertake to solve mathematically challenging problems arising from war projects. Mathematicians, especially the emigrés, turned to the task of winning the war (an early NYU report was Hermann Weyl's study of shock waves). But Courant's group maintained close touch with fundamental research and the instruction of graduate students.

After the war, many wartime collaborations ended and there was a great surge toward not immediately applicable mathematics: Friedrichs taught topology, for example. Courant retained and strengthened his connections to the government. The Office of Naval Research encouraged further growth of the group and supported the open, unrestricted mathematical research that Courant wanted. In 1946 the group was formally named the Institute for Mathematics and Mechanics and at the same time incorporated a separate applied mathematics group at NYU mainly doing electromagnetic wave propagation under Morris Kline. It also acquired somewhat more reasonable space rented from the American Bible Society, so the chattering of the dormitory was replaced by the singing of hymns. About this time plans were started for a journal, *Communications on Pure and Applied Mathematics*, which first

appeared in 1948. Friedrichs and Stoker threw their energies into making its early issues a success. It was to be, unlike other journals, long on exposition and applications. The first year Friedrichs contributed no less than five papers, including his well-known article on the formation and decay of shock waves and his fundamental work on the perturbation of continuous spectra.

In the years following the war, many of the present older faculty completed their studies in the new institute. Courant and his group of advisers, now including Fritz John, found their best candidates for continuing positions among them.

In 1952 the Atomic Energy Commission (today a part of D.O.E.) selected NYU as the site for the first university large, high speed computer (Univac). Courant always said that his ambivalence on accepting this offer was wiped out by the enthusiasm of Friedrichs and Stoker.

The new machine demanded more space, more staff, and more positions, and the institute grew accordingly. By now Lipman Bers and Wilhelm Magnus were playing important roles especially in the broadening of the graduate education. Stoker took up the computing enterprise enthusiastically with some novel approaches to the flow of flooding rivers. New blood from the world of scientific computation was brought in.

Inevitably the success of the group led to tempting offers from outside and Berkeley tried to entice all of them to the west coast. But Courant decided to stay where "the reservoir of talent" was.

The mission of the Institute expanded. Harold Grad initiated and led for twenty years a group dedicated to the study of fusion energy and the related basic research fields of plasma physics and kinetic theory. Computer science was begun as a program within mathematics and spun off as a department in the late sixties.

In 1958, at the age of 70, Courant retired from his directorship and was succeeded by Stoker. Soon the Institute was renamed the Courant Institute of Mathematical Sciences. Stoker's greatest battle during his tenure as director was to win for the institute a measure of autonomy. Since his day, the Institute has reported directly to the president of the university, truly a tribute to the special role it has played in NYU's development, and also, one should add, to its ability to grow and manage its own affairs. Among the many appointments made while Stoker was director were Paul Garabedian, Michel Kervaire, and Kurt Symanzik and during this era Jurgen Moser returned from MIT.

In 1963, with a generous helping hand from Courant's friend and advisor, Warren Weaver, the Institute's needs for development were recognized by A. P. Sloan and through a substantial grant from the Sloan Foundation

a new program for postdoctoral visitors, both American and foreign, new scientific programs in probability and mathematical physics and, above all, a new building were made possible. Thus ended the era of remodeled factory lofts and other penurious conditions. Along with the new building came a new "biggest" computer, the CDC 6600, second of its kind to work. It was installed when the building was still unfinished but when it came time for it to be laid to rest in 1980 it was so big it had to be chopped in pieces with an ax.

The new building was known in many parts as the Courant Hilton, it was so luxuriously laid out. The fine tradition of dancing parties, dating to Jim Stoker's early days, was carried over and a special floor built for the purpose in the lounge where to this day the well-known gregariousness of the Courant Institute flourishes.

In 1970, the Institute survived the wave of student radicalism that swept the world, suffering a week's occupation and the planting of a plastic bomb with burning fuse in the computer room. It was extinguished, not by the police bomb squad, but by two enthusiastic young instructors, Chi and Greenleaf, cheered on by Lax and Donsker.

The rest of the seventies were hard years for mathematics and the funding of both the NSF and the defense department agencies declined. NYU was having its own financial troubles and sold its Heights campus in 1972. Joe Keller's satellite graduate program in applied mathematics was wiped out and the Institute suddenly acquired a lot of extra faculty in mathematics. Computer science on the other hand grew with dramatic increases both in student enrollment and government support. By 1980 the building so generous in 1965 was beginning to be inadequate.

New ventures in parallel computing and robotics have expanded the activities of the Institute in the eighties, and the experimental activities are now again in remodeled loft space on Broadway, not so cheap as in Courant's day. The scope of mathematical activities has also broadened to meet the challenges of new applications, especially those tied to computer science.

In 1988, as the American Mathematical Society celebrates its 100th anniversary, the Courant Institute is celebrating the 100th anniversary of Richard Courant's birth. His goal has been achieved and a new young generation is now in place to carry forward his vision. The underlying philosophy of enthusiasm for all parts of mathematics remains. A good bit of Courant's philosophy and a perception of relevance has penetrated the world, and alumni and former postdocs bear influence at all levels. The mathematical community no longer views "the Courant" as just the "impregnable bastion of partial differential equations." One can reflect endlessly on the history of the

Courant Institute and wonder why it succeeded. Why did Lax and Nirenberg choose when they were young to stay at New York University when exciting offers attracted them elsewhere? Why did Friedrichs turn down an extraordinarily generous offer from Rockefeller in the early sixties? What were the elements that stimulated such an active and productive intellectual life? Why, when there were battles, and there were, did it not fall apart? It was not just Courant's skill with mathematical people nor even his ability to transmit his philosophy to those around him. Some of it was a happy juxtaposition of circumstances. But most of it remains a mystery.