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Courant in Göttingen and New York—The story of an improbable mathematician, by Constance Reid, Springer-Verlag, New York, Heidelberg, Berlin, 1976, 314 pp. + 16 pp. photographs, \$12.80.

Richard Courant's life was split into two very different parts on August 21, 1934, the day when he arrived with his family to take up residence in the United States. Ms. Reid tells the story of his life in this absorbing book, in some respects a sequel to her well-known biography of Hilbert. Urged by some of Courant's associates and admirers, she agreed to assist him in preparing his reminiscences at a time when he was already in his eighties. However, as she reports on her third page, "it very soon became clear that I had come too late for the project which Friedrichs had had in mind. Courant had neither the vigor nor the desire to go back over his life meaningfully . . . much as he admired what Klein had done [i.e. in compiling his collected works (Reviewer)], Courant could not bring himself to do something similar. He took comparatively little satisfaction in his past achievements. He was concerned about the future of mathematics and of the institute he had created, and he was frustrated and unhappy because he could no longer help. Not only did he lack the physical and mental energy, but mathematics had passed him by." Nevertheless, from her numerous conversations with Courant and his associates, from documents available to her in Courant's files, and from her extensive work on Hilbert's life and times, she found that she had enough material for a book about Courant. As it now appears in print she calls it a "life-story" rather than a "biography". The distinction is a valid one. In writing a biography she would have needed to go farther afield for her material, consulting additional sources less intimately involved with Courant and his circle. The second part of Courant's life can hardly be put in final perspective without such a broader background. The first half of his career, as student, professor, and administrator at Göttingen, where he was guided by his loyalty and admiration for Klein and—above all—Hilbert, does not seem to require quite the same amount of biographical probing. It is the details of his subsequent attempt to reestablish in America the lost paradise of Göttingen with its high traditions and congenial intellectual atmosphere that merit closer and more extensive examination if the latter half of his life is to be properly understood.

Ms. Reid is to be thanked for the very useful service she has performed in putting down a coherent account of the information she has gathered about Richard Courant. At the same time she is sure to entertain many a curious

reader who would like to know more about a prominent, very active and in some ways controversial figure of twentieth century mathematics in Germany and America—or, more precisely, in Göttingen and New York. It is Courant's unusual and intriguing personality that makes him a fascinating subject for the biographer, and undoubtedly made him difficult for his contemporaries to understand or, in some cases, to appreciate.

Fortunately Ms. Reid has not shied away from the delicate task of delineating Courant's complex character and motivation as they may have contributed to his defeats or his triumphs. She is to be credited with admirable frankness in describing his conspicuous faults and his equally conspicuous virtues. She may have been helped in this by the knowledge that Courant's greatest admirers were clearly aware of these contradictions in his personality and had talked to her quite freely about them. In any case she gives her readers Courant just as he appeared to his contemporaries, "warts and all". Ms. Reid depicts him as being at once aggressive, yet tentative—forthright, yet ambiguous-transparent, yet devious. He liked to keep situations fluid, to avoid committing himself, to maintain ambiguities as long as he possibly could. For instance, he never had a clear understanding with Ms. Reid to prepare his reminiscences with her assistance—quite simply he didn't say "Yes" and he didn't say "No". The reader curious to see other illustrations will find them in Chapter 22, where Ms. Reid treats two incidents at great length. It is not surprising that out of this kind of ambivalence and the sometimes nebulous situations it created, a spark of aggressiveness could be just enough to touch off a serious controversy. Courant's ambitions in America and the role he chose to play here required him to go aggressively into the market place. In doing so he inevitably encountered competition or opposition and made enemies. While in Germany Courant had had less need to follow a similar course but he appears nevertheless to have reaped some criticism for his initiative in seeking funds for the Mathematical Institute at Göttingen from an alien source—the International Education Board. In America his goal of creating a somewhat similar institute involved him in a strenuous and prolonged struggle to acquire the necessary funds under frustratingly adverse circumstances. The price of ultimate success had to be an unusual tenacity of purpose and a readiness to seek out even the most unpromising opportunities and to grasp with alacrity any that could be found or created.

Ms. Reid devotes a great deal of her story, as Courant devoted a great deal of his life in America, to this struggle. If Courant ever told her in so many words that he was guided from his first months or years in America by a clearly defined ambition to create an institute of mathematics centered on certain fields of mathematics close to applications and his own personal interests, I have missed a quotation from him to that effect; but his actions seem to confirm that this is precisely what he sought to do. This goal was not quite that of rebuilding the Göttingen institute in America since there was hardly any place in such a scheme for a Hermann Weyl or an Emmy Noether (neither was available, but distinguished alternates could have been found). Under the circumstances Courant's somewhat narrower purpose was certainly more realistic. Money for mathematics was indeed very difficult to come by

during the great depression and the ensuing lean decade. New York University, his base of operations, was inhibited by its great dependence on student fees from singling out mathematics for special treatment at the expense of other activities. On the other hand, Courant was to declare with increasing frequency over the years his view that the most active parts of mathematics were developing marked but highly undesirable trends toward abstraction and isolation from their respective domains of application. His plans were thus simultaneously the natural expression of a personal philosophy and an attempt to exert a countervailing influence capable of restoring a balance that he saw as increasingly precarious. At times he spoke out with all the fire of a prophet as he worked tirelessly to spread his doctrine abroad in the land that was his second home. In some ways this served to promote the interests of his own group at New York University, but it also led Courant into conflict with other mathematicians whose views differed in greater or less degree from his own or whose efforts to promote mathematics in America took a different direction from the path he favored.

If Courant's motives thus sprang in part from a strong scientific orientation, they also included the desire to reproduce some of the tradition and atmosphere of Göttingen in New York. Thus Courant started to build a new institute here by bringing to it from Germany a small number of excellent mathematicians with whom he had close personal ties and on whom he could rely to work with him in harmony. This was important because as a German professor he was accustomed to deal with students, assistants, and junior colleagues in ways that would have been misunderstood or rejected by mathematicians not familiar with his background. In this Courant showed sound judgement, as he also did in his particular choice of the first colleagues to join him in the new venture. For him it was surely a great satisfaction to bring a bit of Göttingen to America, creating here a nucleus where he could work at ease in a familiar atmosphere of scientific intimacy and Gemütlichkeit. As Mrs. Courant wrote in the early days of their American experience, "It is wonderful how more and more of Richard's friends are in the vicinity. That pleases Puss-in-Boots and makes him purr." In the long run the initial character of the group was gradually transformed as it expanded, until the German tradition was merged little by little into that of a more or less typical American university department or institute. Ms. Reid does not stress this evolution in her story of Courant's later years though she seems to hint that it may have played some part in the frustrations he felt, particularly after his retirement as director in 1958. It is clear nevertheless that he must have taken great pride in his achievement as founder of the Institute of Mathematical Sciences, profound satisfaction in his role as director from 1953 to 1958, and quiet delight in the work going on there during his tenure. One may guess that those days were among the happiest of his long life, surpassed only by those between 1929 and 1933 when he presided over the Mathematisches Institut of Göttingen, unaware of impending tragedy.

As one peruses Ms. Reid's account of the obstacles Courant had to overcome in his efforts to establish these two institutes, one realizes that she has recast in her own words Courant's reminiscences as told to her, but has not herself investigated in any depth the history of the events she describes

nor attempted to put them in a perspective differing very much from Courant's own. Thus everything tends to be seen through Courant's eyes. What he did not know or what he chose not to mention or recount, she has not sought to discover or amplify as a serious biographer or historian would have had to do. For example she does not, except in one or two short passages, try to recreate for readers with no personal knowledge of the twenties and thirties the atmosphere in which Courant sought to realize his ambitions. Many of his difficulties he shared with his American colleagues whether or not he realized it. The Great Depression and the long period of economic stagnation that followed it made money for the support of science and scholarship in the United States very hard for anyone to obtain. Despite this, American universities did a tremendous job in finding places for their colleagues who, like Courant, had been forced to leave Europe. Often those places were not commensurate with the achievements and standing of those to whom they were offered. On the other hand, places of any kind were so scarce that even such a thin welcome as this meant that many young American mathematicians could find no jobs at all in our universities and many others had to accept very unattractive posts. Courant seems to have had little genuine feeling or understanding for the situation or the many ways in which it could and did affect his own position and ambitions. In 1941 George Birkhoff commented frankly on the situation, perhaps mindful of the possibility that the war in Europe would bring still more refugees to our shores. He warned that America could not continue to neglect its obligations to the young mathematicians growing up here. Though Birkhoff was well aware of the important beneficial consequences of the aid given our European colleagues in need of it and was quite explicit about this in his address, Courant's single observation to Ms. Reid on the matter was, "Birkhoff was wrong." Indeed, one is left with the impression that Courant interpreted Birkhoff's frankness as nothing more than a sign of xenophobia. Yet, not long after Birkhoff spoke these words, André Weil was teaching trigonometry at an American university he has subsequently mentioned only as "that unmentionable place"; and even some years later so promising a young mathematician as George Mackey was teaching fifteen hours a week of elementary courses and grading his own homework papers.

Courant seems to have felt that some of his most serious difficulties were due to personal opposition, actual or potential, rather than to the hard circumstances of the times. In his conversations with Ms. Reid he mentioned explicitly George Birkhoff and R. G. D. Richardson as having been against him. She records this fact with more or less amplification for which Courant appears to have given her some ammunition. When he was soliciting funds for the institute at Göttingen, Birkhoff visited Germany as a consultant to the International Education Board to report on scientific aspects of the Göttingen request. Courant seems to have been very nervous over this visit fearing that anti-Semitism might play a part in Birkhoff's assessment for the Board. In some obscure fashion this has become linked with Norbert Wiener's simultaneous presence in Göttingen. She states that Courant was worried over having the two men as visitors at the same time but does not explain why he should have been. However, she is prompted to quote Wiener's

characterization of his relations with Birkhoff, presumably from one of Wiener's autobiographical works of a very much later date. I could indulge in a little speculation as to what was going on then and in Ms. Reid's conversations with Courant about the matter so many years after the event. If Ms. Reid had done so herself she could have avoided quoting Wiener and found a better source of information to explain Courant's belief that Birkhoff was anti-Semitic. Wiener's transparent ambition to be appointed to a Harvard professorship, in which he was probably encouraged by his father, left him little room for objectivity in his explanation as to why his ambition was never realized. In particular, I do not believe that the anti-Semitism or the personal vanity of anyone was ever an obstacle to the appointment for which he yearned. So far as Birkhoff is concerned, I knew him too long and too intimately to give credence to Wiener's statement. Instead of quoting Wiener, Ms. Reid would have done better to quote D. D. Kosambi's death notice of Birkhoff in one of the Indian journals. To my knowledge there is no better or more honest discussion of the point at issue. As Kosambi says and as I firmly believe from my own long, personal association with Birkhoff, he never judged a mathematician's work by anything other than the work itself and never let personal feelings enter into his decisions where scientific merit was or should have been the major consideration. In other words, whatever Courant may have thought about Birkhoff in the twenties or later on, his fear that Birkhoff would submit a biased recommendation was groundless—as the event seems to have proved.

In later times Birkhoff could perhaps have helped Courant by throwing his great influence behind Courant's projects but the fact that he was apparently not interested in doing so cannot properly be construed as opposition. He also did not, so far as I know, throw his influence behind Richardson in the latter's labors to create a school of applied mathematics at Brown. Ms. Reid should have made it clear in her book that, while Richardson was certainly in competition with Courant in working toward a similar goal, this also could not properly be construed as opposition. Sometime in the thirties, Richardson had brought together enough competent mathematicians with interests in the applications that he was ready to create a school separate from the department of mathematics at Brown. He then set up an advisory board consisting of Theodore Theodorsen as chairman, Thornton Frye, and myself. I was therefore in touch with Richardson's thinking about applied mathematics in America over a period of several years, up to the time when Prager was invited to head the new school at Brown. In none of our meetings did Richardson show any concern over Courant's ambitions. Actually, the school at Brown developed along quite different lines from those Courant had in mind. It could perhaps have been described as a school of higher engineering mathematics, keeping much closer contacts with the applications of continuum mechanics than Courant's group tried to do. As Ms. Reid writes in her book, using a somewhat oblique approach to the heart of the matter, Courant had treated Richardson very shabbily when the latter was a graduate student at Göttingen. Naively Courant seems to have thought or hoped that all he had to do to obtain Richardson's friendly backing years later was to approach him in an ingratiating manner. Even more naively he seems to have

thought that, once placated, Richardson would be willing to promote Courant's plans as well as his own. When Richardson did not react as Courant hoped, he was marked down in Courant's book as an opponent. Ms. Reid cites no concrete evidence of anything like active opposition or enmity on Richardson's part except for a purloined letter from Richardson to a third party which she was not able to see (cf. her Chapter 22).

Without pursuing the matter any further, Ms. Reid briefly mentions Courant's interest in a plan still more ambitious than the one he was able to carry out at New York University. Even at the beginning of his life in America he seems to have thought in terms of a separately endowed national institute of "applied mathematics" and tried to interest others in the plans he had in mind for it. He learned quickly enough from Richardson and others that American opinion was not ripe for such a scheme at a time when university departments of mathematics had to struggle very hard for any expansion at all of the very modest role assigned them by their administrations. He found that the practical course was to accommodate himself to the existing circumstances and work within a university that was seeking to improve its own department in some degree, at least. However, Courant did not forget his more ambitious dreams, returning to them at intervals as he made progress with the situation at New York University. Indeed, he evidently came to understand that in a country as large, as diverse and as competitive as the United States there are major obstacles to establishing a single national institute dedicated to a single narrow purpose. As he did so he reacted by broadening his scheme until he was thinking in terms of a constellation of scientific institutes scattered around the country, each dealing with its own spectrum of scientific disciplines of which mathematics might be but one. I regret very much that Ms. Reid did not follow up her opportunity to elicit from Courant a final, more detailed version of his ideas. As his interlocutor she might have pressed him to elaborate the proposals he had been making over the years in conversations and in letters. As an imaginative mathematician and organizer Courant would surely have had a great deal to contribute to the inevitable discussions of how to maintain the vigor of mathematics, science and scholarship as the socialization of America steadily proceeds. His ideas would have had special interest and value for us in these times when education, scholarship, and scientific investigation here and abroad are clearly menaced by politically determined and sometimes imposed degradation.

While it is conceivable that Courant would not have consented to a more thorough exploration and exposition of his own private glimpse of utopia, there were other parts of his life's work that Ms. Reid could have treated on her own initiative in a much fuller and more illuminating fashion. Certainly, by offering a more detailed account of the structure and functioning of the Institute of Mathematical Sciences itself, she could have given her readers a more striking measure of Courant's genuine achievement there without departing from objectivity or venturing any judgements of her own. By giving more attention to the high quality of the membership and program of the Institute and describing its many achievements in teaching and research, she could have provided convincing concrete evidence of its important place in

American mathematics. Another phase of Courant's impressive activities which she passes over very lightly is his long-time service to the Springer-Verlag as consultant and editor. While Ms. Reid clearly appreciates the cordial and fruitful nature of Courant's association with Ferdinand Springer, she does not take pains to show in detail how productive it was or how important for the development of mathematics. A mere listing of the new mathematical publications undertaken by Springer during the active period of that association would have been enough to give more than a glimmering of its significance for mathematics.

Ms. Reid devotes considerable space to Courant's service as an eager mathematical consultant during World War II. When she describes in an earlier chapter his technical service as a youthful German officer during World War I, she foreshadows the urgent obligation he felt so many years later to play a more mature, more important role as a loyal and grateful citizen of the United States. Her account is full enough to show the energy and scope of Courant's efforts to make himself useful. However, she is at a disadvantage when it comes to describing what he was able to accomplish. This is chiefly because she finds herself in an area where secrecy and compartmentalization have so far made impossible any comprehensive and accurate account or evaluation of the applications of mathematics to military problems during World War II. From my own experience, I may cite a simple illustration of the difficulties that have to be overcome. A distinguished statistician acting as a consultant was asked to analyze the problem of high altitude aerial bombing of naval vessels but was given unrealistic data to work with because the Armed Forces, in safeguarding security, chose not to disclose the true figures. As a result, the statistician's report could not be used till some more trusted expert could determine whether the solution arrived at was stable under the variation of some crucial parameters. What Ms. Reid is able to say is that the study of shock waves is of military importance, that Courant and some of his associates were rather widely consulted about problems in that area, and that the book of Courant and Friedrichs on the theory of shock waves was a valuable unclassified product of their involvement in those problems, whatever they may have been. She seems to have confined herself quite closely to saying just that and little more, except for details which show Courant as a very busy person throughout his period of war work and its sequel in the post-war military-scientific honeymoon.

In a review of Ms. Reid's book on Hilbert, Gian-Carlo Rota has taken the author severely to task for not writing much more about his inner life, both intellectual and emotional. In certain respects, Rota seems to me to have asked for the impossible. A mathematician rarely leaves behind much material out of which a biographer can safely reconstruct the ways in which an important theorem came to be formulated and eventually proved. Abortive calculations and scrap-work are destroyed, conversations with others go unrecorded (sometimes conveniently, it might appear), letters to colleagues are often unavailable or prove to be too sketchy and incomplete. When mathematicians like Poincaré and Hadamard write of the creative experience they stress the point that much of mathematical thinking never reaches the conscious level at all. Most creative mathematicians can confirm this obser-

vation from their own experience. If the mathematician himself cannot tell how he discovered a theorem and found a proof of it, his biographer can hardly be expected to do so. In this sense, Rota was asking Ms. Reid for the impossible. On the other hand there are many things a biographer can do to give a picture of the intellectual life and accomplishments of his subject short of trying to get inside his mind. Ms. Reid has undoubtedly left many such things for some other biographer of Courant to do. Some of them are so simple that she might have done them in her book on Courant, even if she did not do them in the one on Hilbert. For instance, a bibliography of Courant's publications with or without commentary would have been welcomed by many of her readers. Some sort of evaluation of their influence and importance might have been offered, if not the author's own then that of some mathematician qualified to make it. In the case of Hilbert, Ms. Reid published as an appendix to her book Hermann Weyl's masterful analysis and appraisal. It is a pity that she did not or could not do the same for Courant. Even a casual reader of the present book can see that very intriguing questions need to be raised about Courant as a mathematician and as an intellectual. How much was he really influenced scientifically by Hilbert whom he revered so openly and sincerely? Were his mathematical interchanges really limited to a small number of German and American mathematicians and a few Russians who visited Göttingen, as Ms. Reid's life-story seems to show, and how much did these contacts influence him mathematically? How much did he owe to those who assisted or collaborated in his scientific work? Did he read much mathematics outside the circle of his somewhat narrow personal interests? Why did he show so little interest as a mathematician in the profound and amazing transformation of physics initiated early in the twentieth century with the advent of relativity and the quantum theory? While Ms. Reid gives some account of Courant's principal scientific contributions and stresses the wide influence of his books, she has written little that throws any light on these very natural and interesting questions. She has indeed described in some detail the manner of his collaboration with those he brought to New York to work with him, but leaves this largely at the level of anecdote without inquiring more deeply into the matter. Under the circumstances which prompted her to gather her material and eventually to publish her book, interesting as it is, she may very well have felt that she ought not attempt a study of her subject in any greater depth. Whether this be so or not, she has gone far enough to throw open areas capable of tempting a future historian or biographer to pick up where she left off. The mounting interest in the history of American mathematics and an increasing emphasis upon breadth, accuracy, and depth in the writing of it seem likely to call forth less anecdotal and more critical treatments of Richard Courant in America, of such a kind as the prominence of his achievements warrant.

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