BULLETIN (New Series) OF THE
AMERICAN MATHEMATICAL SOCIETY
Volume 32, Number 3, July 1995

The emergence of the American mathematical research community, 1876–1900: *J. J. Sylvester, Felix Klein, and E. H. Moore*, by Karen Hunger Parshall and David E. Rowe. History of Mathematics, vol. 8, Amer. Math. Soc., Providence, RI, and London Math. Soc., London, 1994, xxix + 500 pp., $100.00. ISBN 0-8218-9004-2

This is a book to study—to read from cover to cover, or to skip the more technical mathematical parts—to dip into—to browse in—to refer to. It is profusely illustrated with photographs of individual mathematicians and groups as well as with seven photographs of locations relevant to the narrative (some pretty dreary-looking spaces for the exciting mathematics that was taking place in them). It is a book that should be on shelves at home as well as in libraries.

As eighth in the History of Mathematics series inaugurated by the American Mathematical Society with its three centennial volumes, this is the only other volume in the series that deals with the history of mathematics in America. The authors point out in their preface that this subject (along with the history of mathematics in general) has been "relatively neglected" in recent times by American historians of science. In their book they do much to remedy the situation in regard to American mathematics, ranging well beyond the quarter century of their title. The first chapter provides an overview of American mathematics from 1776 to 1876, and the last takes the American mathematical research community that had emerged between 1876 and 1900 up to the eve of the great mathematical migration from Nazi Europe.

Readers need not go beyond the slick hard cover to see that they have an exciting and illuminating experience ahead of them. A handsome wraparound photograph of the Court of Honor at the Chicago Columbian Exposition of 1893 (a pivotal date in this history) serves appropriately as background. Superimposed is another photograph, this one of the Göttingen Mathematische Gesellschaft; on the back are portraits of the three protagonists of the drama that is to unfold—the Englishman J. J. Sylvester, the German Felix Klein, and the young American E. H. Moore.

I use the word *drama* without apology. The emergence of a mathematical research community in the brief span of twenty-five years is as dramatic a change in the history of American mathematics as that wrought by the influx of distinguished European mathematicians in the 1930s, even though the latter—in less than a decade—shifted the balance of mathematical power from the Old World to the New. What makes this book so unusually readable is that the change it treats was brought about largely by three individuals, all coincidentally and inextricably linked. As a result it has something of the quality of a great, sprawling novel.

In 1876 Daniel Coit Gilman, the first president of a newly founded, generously endowed university in Baltimore, the Johns Hopkins, offered its first professorship of mathematics to an eccentric and combative sixty-one-year-old Englishman. Although elected to the Royal Society at twenty-five and scientifically honored abroad as well as at home, J. J. Sylvester had been forced at fifty-five into retirement. If anyone deserved the word "difficult", and possibly "questionable" as well, Sylvester did. In the five years of his retirement, producing hardly any mathematics (just eight short articles), he had spent most of his time reading the classics, writing poetry, and composing a pamphlet titled "The Laws of Verse". In spite of his scientific reputation, his productive scientific life might seem to have been over. Yet Gilman not only offered him a position but also agreed to his demand for a larger salary than that then paid to any American mathematician.

The story of how Sylvester in his new position experienced a second mathematical youth, stimulated mathematical research in America, and served as editor of the first American mathematical research journal is familiar in its broad outlines, but here it is told in fascinating and sometimes surprising detail. For example, I had always been under the impression that Sylvester was the founder of the *American Journal of Mathematics.* In fact, the idea was President Gilman's. "I said it was useless; there were no materials for it," Sylvester recalled. "Again and again he returned to the charge, and again and again I threw all the cold water I could on the scheme." Although Sylvester did agree to become the first editor, he limited his duties to the mathematical aspects of the project, insisting that his mind be "undisturbed by being mixed up in any way with its financial arrangements."

Chapter 2, "A New Departmental Prototype", provides the biographical and mathematical background for Sylvester's seven years at the Johns Hopkins. Tables at the end of the chapter list the mathematical fellows at the university during his tenure and the courses, both undergraduate and graduate, that he and they offered. Chapter 3 treats in detail the actual mathematics being done in Baltimore at the time.

In 1883, with Sylvester proposing to return to England, the second protagonist enters the story. Felix Klein was a much younger mathematician, half the Englishman's age. He had flared to prominence early but had recently suffered a breakdown that had essentially ended his career as a creative mathematician. Although others had not yet perceived his situation, Klein saw it clearly and had consciously begun to turn his genius to becoming a "Master Teacher". Later, in Göttingen, he would take on pedagogy and organization, weak words for the grandeur of his conception of his task.

At the time Klein was being offered the opportunity to succeed Sylvester, he was also being offered the position in Göttingen. Although he eventually rejected the Hopkins offer, his effect on American mathematics would be powerful, much more so than Sylvester's.

The authors do not simply present their protagonists and their mathematical accomplishments. In every case they examine "the confluence of historical trends and events which enabled this disparate trio to emerge as *the* dominant figures in the creation of a community of mathematical researchers... ." Doing so is especially necessary in the case of Klein, and in Chapter 4 they interrupt their account of events in America to turn to relevant mathematical developments in Germany. This chapter, "German Mathematics and the Early Mathematical Career of Felix Klein", and the following chapter, "America's *Wanderlust* Generation", present Klein before 1893, when for the first and only time he came to the United States. The section headings for these show the authors' thoroughness in providing context. They also suggest tantalizing opportunities for browsing:

The Göttingen Mathematical Tradition
Klein's Educational Journey
Anschauung, Riemann Surfaces, and Geometric Galois Theory in Klein's Early Work
Professor of Geometry in Leipzig
The Ascension of a New Star [Poincaré]

Klein's [American] Leipzig Students
Two German Emigres [early careers of Bolza and Maschke]
The Kleinian Connection in American Mathematics
Two Seminar Lectures by Henry White
Studying outside Göttingen
Studying with Sophus Lie in Leipzig
The Women Make Their Mark (Don't miss this description of Klein's modus operandi.)
The Kleinian Legacy

American mathematicians flocked to Klein in Göttingen, as earlier they had flocked to him in Leipzig. The German conception of mathematical training and research became ever more firmly established as the American ideal. Klein himself, more than any other German mathematician, came to embody that ideal—most relevantly here for the young American, Eliakim Hastings Moore. In 1891, barely twenty-nine and essentially untried as mathematician or administrator, Moore was chosen by President William Rainey Harper to be the first professor of mathematics and the "acting head" of the mathematics department at another newly founded and generously endowed American institution of higher learning, the University of Chicago.

At the same time that Harper chose Moore to set up his mathematics department, he invited Klein to come to America for a twelve-week lecture tour, an indication of the kind of support Moore was to receive from his president. The lecture tour did not come about; but in 1893 Klein, as the official representative of the German government, participated in the "international mathematical congress" held by Midwestern mathematicians in conjunction with the Chicago Fair. He then remained in the area long enough to present the famous "colloquium" at Evanston. Although the participants in these events were largely from the Middle West and both events were small in comparison to others connected with the Fair, their importance for American mathematics can hardly be overemphasized. Parshall and Rowe give them all the space they deserve—in fact more than fifty pages, approximately the same number they devote in their opening chapter to the first century of American mathematics.

Moore, in proposing his departmental plan to President Harper, had emphasized that he wanted to get some of Klein's men. Harper had thought one other man should be enough to start with, but Moore managed to obtain two former students of Klein, Oskar Bolza and Heinrich Maschke, by the sheer luck that Bolza refused to come without Maschke.

These three mathematicians immediately began to put together a mathematical curriculum at the undergraduate level, the sophistication of which, according to the authors, "was unprecedented in the history of higher [mathematical] education in the United States." They then turned their attention to strengthening their graduate offerings to "reverse the trend that had allowed Göttingen and other German universities to monopolize [the] final phase in the training of America's best mathematicians." This was a formidable challenge, since, by 1895, Klein had been joined in Göttingen by David Hilbert.

That the Chicago mathematicians succeeded admirably is demonstrated by the quality of the Ph.D.s they produced and by the extent of these students' geographical influence: L. E. Dickson (1896) and G. A. Bliss (1900), eventually both at Chicago; Oswald Veblen (1903) at Princeton and the Institute for Advanced Study; R. L. Moore (1905) at Texas; and G. D. Birkhoff (1907) at Harvard. It is hard to imagine a more impressive list.

But the Chicago mathematicians did more than produce outstanding research mathematicians. They and other Midwestern mathematicians that had attended the International Congress and the Evanston Colloquium Lectures recognized the importance of a research *community* of mathematicians. They now campaigned successfully to establish an official Midwestern section of the American Mathematical Society (formerly the New York Mathematical Society) and "began what would ultimately be the slow process of making the AMS an organization of truly national proportion and influence." A few years later the same mathematicians were instrumental in establishing another, much needed research journal, the *Transactions of the American Mathematical Society*, which would publish only research that had been reported in person or in absentia at an official meeting of the Society. E. H. Moore was its first editor.

Three years later Moore became the sixth president of the AMS, at thirty-eight the youngest by twelve years as well as the first pure mathematician to head the organization. "Rather than concentrating on the mechanics of building the Society [during his two years in office]," according to the authors, "he took the opportunity... to champion the advancement of mathematics education at all levels of the curriculum nationwide." This also was in the tradition of Klein, whose interest in pedagogy extended to elementary education and to mathematical lectures for those who were not going to become researchers.

The fact that the authors devote so much space to Klein is not to minimize the importance of Moore, who was the right man in the right place at the right time. What Sylvester had begun and Klein had inspired, Moore brought to reality.

The perfect foil for Moore and his activities on behalf of American mathematics is, interestingly, one of the few American mathematicians before 1900 who had an incontestable international reputation—Josiah Willard Gibbs. Like Moore, Gibbs was a student of Hubert Anson Newton, Yale's professor of mathematics from 1855 to 1896; but unlike Moore, he was neither "dynamic" nor "enterprising", the adjectives with which the authors introduce Moore. "Shy and retiring", he had few students and was so uninterested in the organizational developments that were taking place in American mathematics during his professional career that he joined the American Mathematical Society only a month before his death in 1903.

Chicago's heyday in American mathematics lasted approximately a decade and a half and ended almost as abruptly as it had begun. In 1908 Maschke died, and two years later Bolza, bereft of his longtime friend, returned to Germany.

In view of the authors' frequent references to the achievements of Chicago's "first fifteen years" and the fact that most of its famous mathematics Ph.D.s—who were to be the leaders of American mathematics in the next period of its history—took their degrees *after* the turn of the century, readers may not recognize immediately the rationale behind the selection of 1900 as the cutoff date for the period being treated. The authors explain that they have limited themselves to the *developments* that permitted a mathematical research community to emerge: the absorption of the German research ideal, the holding of an international congress and a series of high-level colloquium lectures, the organization of an officially recognized section of the AMS beyond the East Coast, and the founding of a significant new research journal:

> [A]s more universities and colleges fell under the influence of the curricular advances at the undergraduate level made at institutions like Hopkins and Chicago, the educational foundation needed to produce mathematical researchers grew more solid. By the turn of the century, the construction of American research mathematics was well under way.

Although the authors are quite certain that a mathematical research community had emerged in America by 1900, they seem less sure about where their story ends. In their preface they write that "the notion of periodization ... is central to the argument and to the overall structure" of their book. "By targeting the *period* from 1876 to 1900, it explicitly delimits the boundaries of two other periods in the history of American mathematics. Thus, the book's discussion of this key quarter-century is motivated by an examination of the prior period, and its argument is solidified by mapping the contours of the one which followed." But in their epilogue, "Beyond the Threshold: The American Mathematical Research Community, 1900–1933", they go beyond 1933 to a fourth, less clearly defined period, 1933–1960, "which saw the massive influx of European mathematicians ... , the development of various areas of applied mathematics, and the institutionalization of large-scale governmental funding of basic research both during and after the Second World War."

In particular, the authors emphasize a change in the orientation toward applied mathematics as one of the most dramatic results of the integration of the European emigrés into the American mathematical community. Curiously though—in view of what has gone before in regard to the influence of Klein—they make only passing reference to Richard Courant, the successor whom Klein handpicked in 1922 to carry on his organizational work in mathematics and his ideas about mathematical education. Klein had by no means turned Göttingen into a citadel of pure mathematics. Recall that it was he who brought Carl Runge into the small mathematical faculty and that the physicists Max Born and James Franck as well as the aerodynamicist Ludwig Prandtl were all an accepted part of the mathematical community. Courant saw maintaining such close contacts between the mathematical sciences and science as a whole as an important part of his mandate from his predecessor. In 1934, as one of the first professors removed by the Nazis, he fled Göttingen for a modest position at New York University and, recognizing early the dangers inherent in the American overemphasis on pure mathematics, began to proselytize for a mathematics that included the applications.

In his autobiography, Warren Weaver, who headed the Applied Mathematics Panel during the Second World War, commented indirectly on Courant's success:

> For a few years after the war there were plans at several important locations for substantial, if not major, development of applied mathematics. It is distressing to have to record that in general these brave starts were not sustained. There are, fortunately, present indications of useful reintegration of all aspects of mathematics at several universities.... And since the war there has been one truly significant development, at New York University.

The authors did not actually need to go beyond 1933, their cutoff date for the third period in the history of the American research community; but since they did, they might well have brought their account of Klein and his influence on American mathematics full circle with some specific reference to the relationship between him and Courant.

Otherwise I have only minor criticisms.

It is to be regretted that among the portraits there is none of Daniel Coit Gilman or William Rainey Harper. In both cases their conception of what a university should be played a decisive role in what was done mathematically at their institutions. Titles of the various interesting tables are for some reason not given in the table of contents, so on occasion these are difficult to locate. The extensive bibliography tempts one to further reading, particularly of a biographical nature; but the autobiography of Weaver, mentioned above, is not listed, nor is the lively chapter on Sylvester in E. T. Bell's *Men of mathematics.*

There is no question but that the authors have achieved their goal of "addressing issues of potential interest to a varied audience... and redressing a serious omission in the literature on the history of American science."

Constance Reid
E-mail address: chreid@aol.com

BULLETIN (New Series) OF THE
AMERICAN MATHEMATICAL SOCIETY
Volume 32, Number 3, July 1995

Barrelledness, Baire-like and (LF)-spaces, by Michael Kunzinger. Pitman Research Notes in Mathematics Series, vol. 298, Longman Scientific & Technical, Harlow, Essex, copublished with Wiley, New York, 1993, xiii+160 pp., \$46.95. ISBN 0-582-23745-9

This volume of research notes is concerned with a theory that has evolved over the last twenty years or so. It presents a fairly complete account of the results that have been obtained on classes of locally convex spaces (l.c.s.) which include all Baire spaces and are contained in the class of all barreled (or tonnelé) spaces. (Nobody seems to follow the reviewer's Webster spelling of the word "barreled", but so be it.) Every beginning student of abstract analysis is exposed to the concepts of Banach spaces and Frechet spaces (or (F)-spaces,