A Singular Genius

The Man Who Knew Infinity. A Life of the Indian Genius Ramanujan. ROBERT KANIGEL. Scribner, New York, 1991. x, 438 pp. + plates. $27.95.

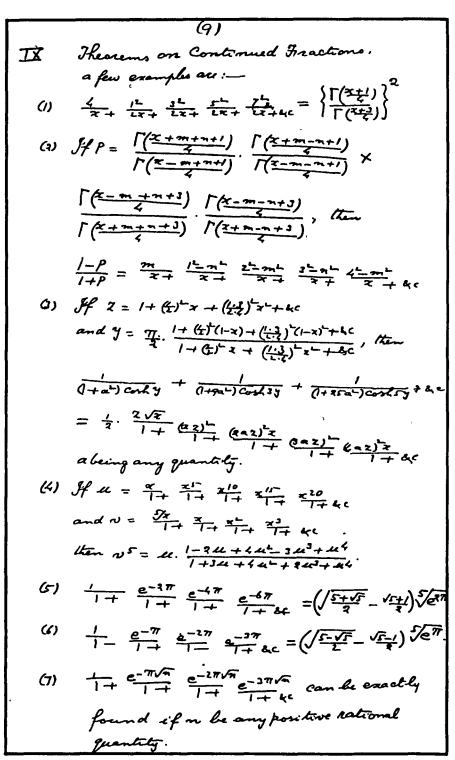
This is the romantic and ultimately tragic story of the singular mathematical genius Srinivasa Ramanujan. An easy tale to tell badly; over the years the story has been much contaminated by apocrypha and misinterpretation. The outline, however, is straightforward enough. Born in 1887 into a poor but high-caste (Brahmin) family from Kumbakonam in southern India, Ramanujan, against seemingly impossible odds, became a major mathematical figure. He was inadequately and incompletely educated, and though he exhibited a precocious gift for mathematics he was unable to complete an orthodox mathematical training. He lived in poverty and disease and bore the scars of smallpox. Too poor at times to afford paper, he did much of his mathematics with chalk and slate. Yet by the age of 25 he had, in relative isolation, discovered and rediscovered a tremendous body of mathematics. Ramanujan communicated these results to some of the leading English mathematicians of the day, probably including H. F. Baker and E. W. Hobson, who never responded, presumably dismissing Ramanujan as a crank. But the preeminent English mathematician of the period, G. H. Hardy (1877–1947), and his great collaborator, J. E. Littlewood, recognized in Ramanujan a touch of genius. Hardy would later write of the results Ramanujan had mailed in early 1913 that some of them

> defeated me completely; I had never seen anything the least like them before. A single look at them is enough to show that they could only be written down by a mathematician of the highest class. They must have been true because, if they were not true, no one would have had the imagination to invent them.

Hardy initiated serious efforts to bring Ramanujan to Trinity College, Cambridge. Another Cambridge analyst, E. H. Neville, traveled to India in 1913 to lecture and to secure Ramanujan's agreement—an agreement made difficult because of prevailing Brahmin taboos on travel. Funding was also lacking for a stay originally planned for two years, and it is significant that most of the money was provided by Indians and Anglo-Indians, not by Cambridge.

Thus in 1914 Ramanujan arrived in England: 26 years old, a devout Brahmin and vegetarian. He was unready for Cambridge ritual and English reserve. A brief but wonderfully fruitful collaboration with Hardy followed. It married Hardy's superb technical skills and knowledge to Ramanujan's intuition and uncanny capacity to divine identities. From 1914 to 1919 they produced a number of important and beautiful joint papers on number theory.

While the collaboration flourished Ramanujan's physical and mental health decayed. Most of 1917 and 1918 were spent in sanatoria. Ramanujan was diagnosed as having tuberculosis, no doubt exacerbated by wartime rationing and his strict vegetarian diet. In 1917 he was turned down for a Trinity fellowship and for membership in the Royal Society. An unsuccessful suicide attempt followed early in 1918 (he jumped in front of a London Underground train). His declining health may have precipitated a change of heart on the part of the Royal Society. Ramanujan learned in late February 1918 that he would become an F.R.S., and that autumn Littlewood succeeded in having him elected to a fellowship in Trinity in the face of opposition, some of an openly racist nature. When the war ended he returned to India, where he died prematurely in 1920. His extraordinary final work, produced while he lay dying, is now often and controversially identified as the "Lost Notebook." (Neither a notebook nor lost, it consisted of almost impenetrable notes on loose pages in Trinity's library; it was "discovered" and mathematically illuminated by George Andrews in 1976.)



A page of Ramanujan's first letter to G. H. Hardy. [From *The Man Who Knew Infinity*; Syndics of Cambridge University Library]

Ramanujan's legacy includes his famous "Notebooks": two large handwritten books densely packed with strange and exotic formulas, usually without much derivation and usually in his own nonstandard terminology. (A sample of the notebooks would have been a pleasant addition to this work.) The task of fleshing out the details in these notes has occupied some very talented mathematicians over the decades and is only now nearing completion. This work covers a profusion of results in the theory of series, integrals, asymptotic analysis, and elliptic and modular functions. It is appearing as three substantial volumes (two of which are already out) edited by Bruce Berndt, with complete proofs provided. Working mathematicians are often reminded of Ramanujan's impact on mathematics by the functions, series, and conjectures that bear his name.

This is the rough cloth of the Ramanujan fabric; the embroidery is more elaborate. All too often Ramanujan is reconstructed as some kind of divinely inspired mystic who rediscovered several millennia of mathematics while walking the dusty roads of southern India. Or, worse, he is painted as an idiot savant and a calculating prodigy. Getting the fabric right is hard, and here *The Man Who Knew Infinity* is most successful.

No, Ramanujan did not recreate all pre-20th-century mathematics by himself, but his education was far from mainstream. His primary source, Carr's 1886 *A Synopsis of Results in Pure and Applied Mathematics*, was a compilation of some 5000 formulas and theorems that covered large parts of 19th-century mathematics. As in Ramanujan's notebooks, little is proved. Still, most of the familiar objects of Ramanujan's mathematical hope chest are introduced and examined by Carr. Nor was Ramanujan entirely self-educated. He did attend college for a period

in both Kumbakonam and Madras, failing because of inattention to the nonmathematical curriculum.

Yes, Ramanujan was enormously gifted, particularly in the formal manipulation of series, continued fractions, and the like. But even here he had historical peers, albeit very few, perhaps only Euler and Jacobi.

It is only by the delicate thread of Hardy that Ramanujan escaped falling to obscurity. Had Hardy not recognized Ramanujan, who would have? Hardy called Ramanujan "the one Romantic incident in my life," and perhaps rightly, but the sophisticated, exquisitely educated, and iconoclastic Hardy is almost as interesting a study as Ramanujan himself. Hardy didn't need Ramanujan. Indeed, Ramanujan wasn't even his most famous collaboration. The works of Hardy and Littlewood are so pervasive that it has been said that there were three great English mathematicians of the period: Hardy, Littlewood, and Hardy-Littlewood. But Ramanujan needed Hardy, and as the two stories cannot be separated, Kanigel also provides us with an intriguing portrait of the earlier parts of Hardy's somewhat eccentric life.

Where does Ramanujan belong in history? In raw ability, Hardy rated Ramanujan at 100 and Hilbert at 80, while Littlewood scored 30 and Hardy 25. But Hardy's and Littlewood's individual effects on the stream of mathematics were more profound, as of course were Hilbert's. Nonetheless, Ramanujan is a great figure who had a brief four or five years on the world stage to make his mark. As these years overlapped perfectly with the First World War, contact with Europe was impossible and activity in England was much reduced.

Hardy writing in 1940 concluded of Ramanujan's work:

> It has not the simplicity and inevitableness of the very greatest work; it would be greater if it were less strange. One gift it has which no one can deny, profound and invincible originality. He would probably have been a greater mathematician if he had been caught and tamed in his youth; he would have discovered more that was new, and no doubt, of greater importance. On the other hand he would have been less a Ramanujan, and more of a European professor and the loss might have been greater than the gain.

Today the results seem equally original but perhaps a little less strange.

As Kanigel puts it: "Cut cruelly short, Ramanujan's life bore something of the frustration that a checked swing does in baseball; it lacked follow-through, roundedness, completion." Hardy, an avid sports fan, might have liked this metaphor. Kanigel asks, "Would he have become the next Gauss or Newton?" and wonders whether his genius was built of "sheer intellectual

Indian stamp issued in 1962 to honor Ramanujan. [From *The Man Who Knew Infinity*]

power, different only in degree" from the normal or if it was "steeped in something of the mystical." Reasonably, he equivocates:

> In each case, the evidence left ample room to see it either way. In this sense, Ramanujan's life was like the Bible, or Shakespeare—a rich fund of data, that holds up a mirror to ourselves or our age.

Kanigel both provides the data and holds up the mirror in this superbly crafted biography. The hardest part of mathematical biography is including the mathematics, giving it content and life, without destroying the story. Kanigel does succeed in giving a taste of Ramanujan the mathematician, but his exceptional triumph is in the telling of this wonderful human story.

As children of a mathematician (from Hardy's school), we grew up knowing the rudiments of this story. As mathematicians we have had occasion to work in Ramanujan's garden—to use Freeman Dyson's lovely metaphor. For us this book was a pleasure to read. We hope it is for many others. It is a thoughtful and deeply moving account of a signal life.

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A Gendered Life

Jessie Bernard. The Making of a Feminist. ROBERT C. BANNISTER. Rutgers University Press, New Brunswick, NJ, 1991. xii, 276 pp. + plates. $27.95.

The sociologist Jessie Bernard, now in her late 80s, had already passed the conventional age of retirement when the feminist movement of the late '60s radically transformed her intellectual perspectives and inspired her to begin a new phase of her career. Between the ages of 68 and 84 she published six books (including *The Future of Marriage* and *The Female World*) and dozens of articles, works that are generally viewed as her most original and brilliant. It was in this late period that she achieved eminence in her profession, and it would not be an exaggeration to say that she has been canonized as a "founding mother" of sociology.

A study of Bernard's life and work is a worthy project for several reasons: as a window into the history of 20th-century sociology, as a case study of obstacles that women encounter in academe, as an account of one social scientist's deepening insights about gender. Unfortunately, her present biographer does not display a genuine appreciation or understanding of his subject. His treatment of her life is not only dismissive of her work and excessively focused on her early marriage but mean-spirited in its method and approach.

Bannister announces his opinion of Bernard's work in the introduction, when he explains his book is "not an intellectual history of the analytic or internal variety" because "Bernard has not been a deep thinker." In fact, Bannister typically deals with Bernard's work by providing brief summaries of her books followed by extensive quotations and arguments from her most negative reviewers. One might mistakenly conclude from Bannister's evidence that Bernard never found an appreciative audience. Throughout the book, Bannister characterizes Bernard as intellectually superficial and timid, an ambitious seeker of recognition who was always ready to jump on the latest bandwagon. He minimizes Bernard's later and widely admired work as not being especially revolutionary and observes that she was unable to keep up with the more demanding and current feminist theorists. The best he has to say about Bernard is when, trying to account for her appeal, he grants her "openness to new ideas, an ability to articulate issues before others have done so, and an engaging frankness concerning her own shortcomings."

Bannister misunderstands Bernard's importance for a number of reasons. First, he does not recognize that in her later work she was not following fashion but was well ahead of her time and willing to engage in controversial subjects others ducked. Her insights about the darker sides of marriage and the different worlds occupied by women and men even when they share households were highly original and have had a significant and lasting influence on younger scholars. Her thoughts about the impact of gender on the ways social scientists conceptualize and conduct their work opened up debates that are still of