

## Letters to, from, and about Ramanujan

Srinivasa Ramanujan's letter of 16 January 1913 to G. H. Hardy is one of the most famous letters in the history of mathematics. After introducing himself 'as a clerk in the Accounts Department of the Port Trust office at Madras', Ramanujan began to relate to Hardy some of his mathematical discoveries. In this and the following letter of 27 February 1913, Ramanujan set forth over one hundred of his theorems. The day Hardy received this first letter from Ramanujan marks the dawning of Ramanujan's recognition as one of the most imaginative mathematicians in modern times, for that evening Hardy and his collaborator J. E. Littlewood examined the claims made by Ramanujan and found many of them to be profoundly beautiful and original.

Correspondence between Ramanujan and Hardy took place not only before Ramanujan journeyed to England, but also while Ramanujan was confined to sanatoria for two years before returning to India. Before dying in April of 1920, Ramanujan wrote only one further letter to Hardy. Unfortunately, some of the correspondence between these two great mathematicians has been lost.

Of course, Ramanujan wrote many letters to family and friends from Cambridge. Although most of these letters have been lost, several have been preserved. We owe a great debt to P. K. Srinivasan who collected many of these letters and made them available to the general public<sup>1</sup>. Other letters are secured in the library at Trinity College, Cambridge, and photocopies of some were published along with Ramanujan's 'lost notebook'<sup>2</sup> in December 1987 on the occasion of the centenary of Ramanujan's birth. Further letters, mostly from the files of the Madras Port Trust office, are safeguarded in the National Archives in Delhi. Through the efforts of S. Chandrasekhar and the cooperation of the late prime minister Rajiv Gandhi, we have been able to obtain copies of this material.

We are presently attempting to collect all letters to, from and about Ramanujan that still exist, and writing commentary on them. There are several motivations for these efforts.

First, the correspondence between Ramanujan and Hardy contains, as

already mentioned, many beautiful and important theorems. Ramanujan's assertions in these letters spawned several papers by G. N. Watson, C. T. Preece and others in the late twenties and early thirties. Since that time, hundreds of further papers have had their genesis in these letters. We are documenting the influence and history of each of the claims made by Ramanujan in his letters to Hardy. For instance, several wonderful theorems on what is now called the Rogers-Ramanujan continued fraction are communicated in each of Ramanujan's first two letters. The second series of results concludes with the enigmatic statement, '... which is a particular case of a general theorem on continued fractions'. The 'general theorem' is not divulged by Ramanujan. We mention two likely candidates for this general theorem in addition to discussing all the claims made by Ramanujan about this and related continued fractions.

Secondly, many of the people with whom Ramanujan corresponded have been forgotten today. We are preparing short biographies of most of the correspondents. For example, while searching for information about Sir Gilbert Walker, head of the meteorological observatory in Madras and one of the first to recognize Ramanujan's mathematical gifts, we discovered that he is well known to meteorologists today as one of the founders of modern weather forecasting.

Thirdly, many parts of the contents of Ramanujan's personal letters require explanation, especially to readers in the West unfamiliar with Indian places, culture and foods. With the help of several Indian friends and colleagues, appropriate commentary is being written.

Fourthly, we are concerned that letters will be lost if efforts are not made to preserve them. In 1987 Madhava Rao, the son of one of Ramanujan's friends, G. Vinayaka Rao, found three letters from Ramanujan to his father concealed in an old, forgotten suitcase in his attic. These letters were given to K. Srinivasa Rao of the Institute of Mathematical Sciences in Madras, who passed copies to us. In the first of these letters written from Cambridge, Ramanujan confesses to his friend that he felt

unwell for several months during his first winter in England. Thus already there were possible signs of the illness that eventually was to take his life five years later.

Lastly, Srinivasan's collection<sup>1</sup> has been out of print for several years, and very few copies are available outside India. We are therefore anxious that these letters and others not in Srinivasan's book be made accessible to those both within and outside India who have an interest in Ramanujan and his mathematics. Arrangements will be made to have the collection of letters and commentaries jointly published in India and the West.

It should be emphasized that this work is not meant to be a full biography of Ramanujan. Only those parts of Ramanujan's life and work arising from letters are discussed. R. Kanigel's book<sup>3</sup> is the most complete and detailed account yet of Ramanujan's life.

We hope to make our collection as complete as possible, but unfortunately we have been unable to obtain copies of certain letters. In Srinivasan's volume (ref. 1, pp. 56-57), excerpts from letters of Hardy to Ramanujan are given, but we do not have access to copies of the complete letters. In his last letter to Hardy, dated 12 January 1920, Ramanujan briefly discussed some properties of a new class of functions which he called mock theta-functions. Excerpts from this letter are found in Ramanujan's *Collected Papers* (ref. 4, pp. xxxi-xxxii, 354-355), and a photocopy of the complete 'mathematical' portion of the letter has been published with the lost notebook (ref. 2, pp. 127-131). The location of the entire original letter is not known to us. Perhaps there are further letters of which we are unaware. We request that readers with knowledge of any missing letters kindly contact one of us.

Our knowledge of some of Ramanujan's friends and acquaintances is meagre in some instances. For example, on 27 November 1912, Ramanujan visited a mathematician named W. Graham, about whom we know little. S. Narayana Aiyar, the manager of the Madras Port Trust office, appreciated and understood Ramanujan's mathematics more than any other Indian mathematician. We have not located any obituary of Narayana Aiyar; most of our knowledge of him comes from

Kanigel's book. We appeal for any information that would add to our knowledge and understanding of Ramanujan and those whose lives were touched by this remarkable mathematician.

1. Srinivasan, P. K., *Ramanujan Letters and Reminiscences*, vol. 1, Muthialpet High School, Madras, 1968.
2. *The Lost Notebook and Other Unpublished Papers of S. Ramanujan*, Narosa, New Delhi, 1988.
3. Kanigel, R., *The Man Who Knew Infinity*, Charles Scribner's Sons, New York, 1991.

4. *Collected Papers of S. Ramanujan*, Cambridge University Press, Cambridge, 1927; reprinted by Chelsea, New York, 1962.

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## The whys and wherefores of our science

The article by Satish and others on the problems of industrial researchers (*Curr. Sci.*, 1991, 61, 376) makes thought-provoking reading. They have raised a pertinent question in respect of the scientific (and this implies technological as well) research that is going on in our country. Perhaps they posed the question in sheer despair, attempting to seek an identity for themselves. Perhaps they feel that scientists in industrial R&D establishments have not been able to enjoy the sort of freedom available to their counterparts in academic institutions and research laboratories. Perhaps they think that their counterparts elsewhere are given more importance and receive recognition relatively easily. Perhaps they want to gather the satisfaction of having put their own attitude towards research to rigorous scrutiny and thereby having expressed their concern for society.

Whatever the finer details of the objective, the questions Satish *et al.* raise must be answered by the scientific community of this country. What is the social good that we want to accomplish by engaging in scientific research? What are the research problems that really must be solved, and with what priority? Who is the actual benefactor—an individual, an organization, or the nation? And how?

The unfortunate aspect of our scientific

research activity is that those involved in it are not in the habit of giving serious thought to its relevance. The fact that scientific research of every kind is being done the world over, particularly in the West, is itself made the strongest and sometimes the only argument in favour of research in our own country. In effect imitating the West has become a scientific religion for us.

The question of relevance is serious and deserves to be the first point to be considered, because our socioeconomic conditions differ drastically from those in the West. But we evade talking about this relevance except when we must observe some formality while applying for a research grant. The justification of the demand for a grant is often vague and unrealistic, and rarely based on society's needs. Justifying any research activity using the most general terms is not difficult, because, after all, scientific investigations do add to human knowledge. But when adding to human knowledge becomes a costly business, it becomes imperative to rethink carefully, because the country's resources are limited and could be better used in other, more urgent, fields of national activity. One might ask if it is wise to put a great deal of effort and resources to conducting research that is already rigorously being pursued elsewhere and whose results will definitely be available

to us. The real emphasis should have been on putting such knowledge to practical use. This is perhaps where we have failed.

An attitude of finding a compromise between personal gain and fulfilment of social goals is perhaps missing. We devote ourselves to solving problems that interest us purely for academic and intellectual pleasure. It is true that intellectual pleasure has some value, but at what cost? We engage in an activity that best suits our convenience and is in conformity with the training received by us—a training that is rarely designed with any specific purpose in mind. One of our major objectives is to enhance our saleability in the international market, so that we can manage to be in the West. That professional advancement is perhaps the only objective in many cases becomes obvious when one looks at aimlessly designed PhD programmes in our academic institutions. Why should we produce more scientific manpower without first assessing where and how we are going to use it? Once they are produced, work must be found for them. Then the question of professional survival becomes more important than the relevance of the problems they study, and research plans end up so designed that these scientists can be kept busy—whether usefully or otherwise is of little concern.

When the scientific community becomes isolation from society the consequences can be disastrous. We are perhaps nearing that stage. That is why there is no attempt of self-assessment of what we have really accomplished. The fact that, in spite of being the third largest scientific community in the world, we have hardly any breakthroughs to our credit speaks for itself. Even today we are borrowing from the West technology of every nature—an act that we would have been committing had there been no scientific research at all. How much then have we really achieved?

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