Professor M.S. Raghunathan

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On 14 July 2000 one more Indian mathematician affixed his signature to the Register of the Royal Society, London, a parchment book which also bears the signatures of Sir Isaac Newton and many other eminent names in science: Professor M.S. Raghunathan, of the Tata Institute of Fundamental Research (TIFR), Mumbai. Elected a Fellow of the Royal Society this year, he joins the rank of distinguished Indian mathematicians, the legendary Srinivasa Ramanujan, Harish-Chandra, C.S. Seshadri, M.S. Narasimhan, and S.R.S. Varadhan, who have received this coveted recognition.

It is tempting to mention here that the signing in as Fellow takes place at a distinctive function with a traditional flourish on the premises of the Society at Carlton House Terrace in London, and the signatures are affixed with a traditional quill, furnished with a nib that one dips in an ink-pot. A rehearsal is held before the ceremony for the Fellows to practise affixing their signature on parchment. For Raghunathan the recognition (which many in the profession considered long overdue) comes in the wake of a long list of honours, such as the Third World Academy Prize, fellowships of several academies including the Third World Academy (based at Trieste, Italy), the Srinivasa Ramanujan Medal of the Indian National Science Academy, the Shanti Swarup Bhatnagar Prize and others.[1]

Raghunathan also holds the distinction of being invited to give a talk at the International Congress of Mathematicians (ICM) when he was only 29. The ICMs, held once in four years at different centres around the world, are of highest significance to the mathematical community and play an important role in the shaping of mathematics as a continuing discipline. Mathematicians covet being invited to give a talk at the Congress, and only about a dozen mathematicians from India have been invited to give such talks, to all the Congresses together. Raghunathan was invited to give a talk on his work at the Congress held at Nice in 1970, and was one of the first few to represent India in the forum.

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[1]Professor Raghunathan was awarded Padma Shri on the Republic Day, 2001. This article was originally published in the January 5, 2001 issue of Frontline, prior to the award.

A rather unique book *A Panorama of Pure Mathematics* was published by French mathematician Jean Dieudonne in 1977 (the English translation of the original French version appeared in 1982), recounting important results from various areas of pure mathematics, based on the choice of the well-known Bourbaki group in France, in just about 300 pages. Raghunathan was one of the few Indian mathematicians named in the book for having made substantial contributions, though he was still in his mid-thirties when the book was published.

Personally, however, what Raghunathan finds most gratifying is a reference in an interview given by eminent physicist and Nobel laureate, Professor S. Chandrasekhar, which he noticed most unexpectedly, in the *Times of India* on November 18, 1984. The reference ran like this: "On the Faculty of TIFR now, just to mention one name, Raghunathan - he is considered by everyone outside as one of the best mathematical intellects." Professor Chandrasekhar was making a point about what India has been able to achieve in research, and it is apt that Raghunathan's name came to his mind in that respect.

Not surprisingly, the TIFR, the home institution which he joined as Research Assistant before he was 19 (he was nicknamed *"bachcha"*), has also been very appreciative of his talents and success all through his career. He was promoted to the Faculty position of Associate Professor at the young age of 25, and from then on promotions at every stage came early. He currently holds the highest academic position of 'Professor of Eminence'. On his part Raghunathan feels a strong bond with the Institute.

To those who know Raghunathan all this would seem highly inadequate in conveying his personality. The sheer burst of energy that one cannot help feeling while with him is impossible to express in words. It is a unique pleasure, rather an overwhelming one, to watch him think, talk and attack mathematical problems.

Madabusi Santanam Raghunathan was born on August 11, 1941 at Anantapur, Andhra Pradesh, his maternal grand-parents' place. The family lived in Chennai. His father Santanam continued the family's timber business and expanded it through resort to exports to Europe and Japan. He had earlier joined the Indian Institute of Science, Bangalore, after a B.Sc. in Physics, but had to leave his studies mid-way to take care of the family business. Raghunathan fondly recalls that his father had a feeling for science and used

to talk about it, making it very interesting to the children. Raghunathan's mother came from a family with an academic tradition. Her father was an esteemed professor of English, who had contributed articles to the *Cornhill Magazine.* He also wrote, and published on his own, a book on William Makepeace Thackerey, which was later found to have been reprinted in the United States, without his knowledge, indeed in violation of the copyright he held.

Raghunathan had his schooling in Chennai, in P.S. High School, Mylapore and Madras Christian College School. He passed his SSLC (Secondary School Leaving Certificate) examination in 1955. There is a rather interesting story about it: after the Sanskrit paper he absent-mindedly left the examination hall along with his answer paper, and was intercepted on his way home by a fellow student, following commotion at the examination hall on account of the missing answer paper. He narrowly escaped having to reappear for the entire examination, thanks to the headmaster vouching for his integrity.

The University of Madras had the curious restriction of not admitting anyone under the age of 14 years and 6 months, though after attaining that age it was possible to be admitted even in higher classes. Raghunathan therefore pursued his Intermediate at the St. Joseph's College, Bangalore during 1955-57. He then returned to Chennai and joined B.A.(Hons.) in mathematics, in Vivekananda College, which had a very good reputation. "I had good teachers all through" asserts Raghunathan, contentedly. I had earlier heard Raghunathan talk about one of his teachers Raghava Sastri, who had given an intriguing solution to a problem in the *American Mathematical Monthly.* "He had excitement for mathematics and an eye for elegance", Raghunathan added. He also mentioned another teacher for whom he has great regard: K. Subramanian who taught many things outside the curriculum and preferred not to apply too rigorous a regime. S. Narayanan was also very encouraging and indulgent throughout, Raghunathan reminisced.

Raghunathan had a flair for all-round learning. His childhood activities included painting, for which he once won a prize. Even now, often when many of us are engaged in stray doodling, at some long-drawn meeting or not-so-interesting lecture, I find Raghunathan busy making some pretty drawings. An article submitted by him to the college magazine so pleasantly surprised the Professor of English who was in charge of the magazine that he made it a point to call Raghunathan and compliment him.

After completing B.A. (Hons.) in 1960, various possibilities were open to Raghunathan, including preparing for the Indian Administrative Service (IAS), which he would be able to appear for only after two years. In particular he appeared for an interview at the Tata Institute at Mumbai. Raghunathan was elated to be one of only two selected from among some 250 candidates. The other options before him lost out on closer look, and he decided to join the Institute. Although the preparations took some time, he managed to join on August 1, as called upon by the appointment letter, though he had been advised by his father to join on August 2, which apparently might have been an auspicious day for the purpose. The stars, however, do not seem to have minded Raghunathan's transgression. From then on it is a persistent story of professional successes.

After initial training during 1960-62, he worked on a research problem suggested by Prof. M.S. Narasimhan, on "Deformations of linear connections and Riemannian metrics" and solved it by the summer of 1963.

He wrote his Ph.D. thesis under the guidance of Professor Narasimhan and was awarded the degree by the University of Bombay in 1966. Raghunathan has copious and fond memories from his student days of his fellow students and seniors who inspired him. He especially mentions K. Gowrisankaran who was very friendly and helped him settle in the new environment.

He adds that S. Ramanan was a kind of role model for him in those days, as he had joined the Institute with a similar background some years earlier and had held forth in the prevailing competitive academic scenario. "It was a very exciting period" Raghunathan adds, and recalls feeling that much of what has been said in the book *Brighter than a Thousand Suns* (by Robert Jungk) about the University of Göttingen in the heyday of Hilbert applied to the Tata Institute as well!

After completing his Ph.D. Raghunathan spent a year at the Institute for Advanced Study, Princeton, U.S., a well-known international centre for post-doctoral research. As to be expected, through the years he has visited several renowned centers in the U.S., Europe and Japan, on invitation, for various durations ranging from a few weeks to a year, and has spoken in several international conferences.

Let me also state a few words about Raghunathan's mathematical work, in rather general terms. Discrete subgroups of Lie groups have been the

central objects of his researches. The Lie groups, known after Sophus Lie who introduced them in 1873, have had a tremendous impact in various areas of mathematics and physics. By the middle of the 20th century the structure of Lie groups had been well-understood and the focus had shifted to the study of their discrete subgroups, as it was realised that this would be of great significance in Geometry and Number theory. One of the major problems was to describe all discrete subgroups suitably. The so-called rigidity and arithmeticity problems were at the focus of the study.

Raghunathan made major contributions towards that end. Starting from mid-1970s the "congruence subgroups problem" has been his major preoccupation. The problem concerns inter-relation between two classes of discrete subgroups which are crucial from the point of view of Number theory. Through his work Raghunathan is undoubtedly a leader in this central mathematical topic. Raghunathan has also made very significant contributions on geometric questions.

In mathematics, as in other fields, apart from obtaining results it is important to foresee and chart out future directions. Raghunathan has done this successfully, well beyond the areas he pursued. One of his conjectures made in mid-1970s, known after him as the "Raghunathan conjecture", has been very influential in the study of dynamics of a class of flows and their applications in various areas.

Raghunathan's work is characterised by uncommon ingenuity on the one hand and dextrous use of techniques from a variety of areas in mathematics, on the other hand. He embodies the rare combination of a modern mathematician with a drive to prove new results and a scholar in the classical mould interested in imbibing and propagating ideas. It is his lament that too much importance is being given in our academia to producing research papers, inevitably in narrow specialisations, and not enough to acquiring better understanding of deeper mathematics created around the world.

"How many of us can describe the work of at least one Fields medalist?" he asks. He never misses an opportunity to emphasise that good research can only emerge in a milieu of scholarship and that unless scholarship is promoted sufficiently, mathematics in the country would face the danger of degeneration.

Naturally, Raghunathan puts considerable emphasis on students acquir-

ing wide knowledge and attacking important problems, rather than taking shortcuts for a quick Ph.D. Not surprisingly many of his students have gone on to become accomplished mathematicians of international stature, expanding into new areas. He is an enthusiastic teacher, ever eager to explain intricacies of various topics to students, both inside and outside the classroom. It should be mentioned, however, that it could be rather daunting to be his student. Apart from the demands of intense work, one has also to cope with the fact that his thoughts gallop when explaining a point and it is not easy to keep pace with them. Though he explains subtleties of the subject with thorough insight and enthusiasm, he is unfortunately not very good at taking students along small steps of mathematical argument, and often gets stuck at these in his lectures, albeit temporarily, which is often talked of as an amusing feature of his lectures. The way he sorts out the difficulties can itself be quite educative, however.

Raghunathan's book *Discrete Subgroups of Lie Groups*, published by Springer Verlag, Germany, in 1972 is now a classic in the area. It is unique in its coverage of various results which in recent decades have been put to considerable use, and as such it is much appreciated and widely referred to. I have often heard laments of researchers in the field about it now being out of print. The book has been translated into Russian, and published with a foreword by G.A. Margulis, who is a celebrity in the area.

Raghunathan has also played an important role in the promotion of mathematics through various scientific bodies, in both advisory and administrative capacities. He organised the Ramanujan centenary celebrations in Chennai in 1987, with an international conference attended by the foremost number theorists. He is currently a member of the executive committee of the International Mathematical Union. He is also Chairman of the governing council of the Mehta Research Institute, Allahabad.

His most important and comprehensive contribution in this sphere has been his role in the National Board for Higher Mathematics (NBHM). Raghunathan was a member of the Board since it was formed in 1983 and became its Chairman in 1987. He continues to serve in that capacity. The Board has undertaken a variety of activities through the years: apart from providing financial support to mathematics libraries around the country grants for research projects, organising conferences, travel to both national and international events and so on, the Board has also taken a pro-active role in

tapping mathematical talent through various activities, such as Olympiad activity, Mathematics Training and Talent Search, Scholarships/Fellowships at M.Sc., Ph.D. and post-doctoral levels, and the rather innovative Nurture Programme conceived by Raghunathan to support learning of mathematics by students even while pursuing other career options. The International Mathematical Olympiad (an international mathematical competition held annually in different countries) of 1996 was hosted by India, under the aegis of the NBHM. It was quite a feat to have carried it out successfully, in the face of several bureaucratic difficulties, which in particular forced a change of venue from New Delhi to Mumbai barely 5 months before the event.

The various activities of the Board have made a substantial difference to mathematics in the country and Raghunathan's stewardship has been crucial to its success. Raghunathan is grateful to the Department of Atomic Energy for being very supportive of the Board, especially in times of difficulty.

How does he see the future of mathematics in the country? Raghunathan feels that while we have indeed come a long way in the post-independence era, the future poses some serious questions. There is increasing paucity of talented young people taking to mathematics, and our means to meet the problems seem to be quite meagre in comparison to the socio-economic factors responsible for it. Academic pursuit has unfortunately lost the sheen it once had. In the old days a teacher commanded great deal of respect. It is not the case any longer, and this has played havoc. Raghunathan is however optimistic that we will tide over the situation, through persistent effort.

Raghunathan is well-read and has wide interests, aside from the professional ones. He is humanist in approach, and believes that societies should be actively concerned with the uplift of the weaker sections. He holds reasoned views on various issues. He likes to discuss them and is very receptive to what others have to say. He believes in the freedom of expression and feels that academics, particularly, should be able to express themselves without let or hindrance.