

## M. S. Narasimhan (1932–2021)

Recently M. S. Narasimhan, one of the finest mathematicians in the Indian scene, passed away. Coming on the heels of the sad demise of another stalwart C. S. Seshadri, it has been a big loss. I had the good fortune to have had close friendship with both, academically as well as socially. Narasimhan was my Ph.D. advisor, colleague and collaborator for over three decades.

Narasimhan was born in a small village with hardly any infrastructure. There was no High School there and not even bus service to the nearest town where he had to study. Narasimhan often recalled how he had to travel to school in a bullock cart. Although his family was reasonably well to do, his father passed away early and they had to manage with some difficulty.

His performance at the school-final examination was excellent, and he got into the Loyola college, one of the highly rated ones in Madras then. He was very happy with the standard of teaching he received there. The head of the mathematics department was a Jesuite, Father Racine. Unlike most professors at that time, Racine was conversant with contemporary mathematics. Although he was not rated a great lecturer, he took keen interest in students of high calibre and encouraged them to go for research. There was another lecturer, Krishnamurthy who taught Real Analysis, and Narasimhan was appreciative of his efforts to inculcate a deep interest in the subject.

Racine was in touch with the development of the incipient Tata Institute of Fundamental Research (TIFR) in Bombay, and he recommended bright students to take to research in the fledgling institution. Accordingly, some of the students like Seshadri of whom I have mentioned above, and Narasimhan, became graduate students at TIFR. The school of mathematics there had as its head, K. Chandrasekharan (KC), who realized what was the only way to introduce modern mathematics to the Indian scene. KC invited top mathematicians from all over the world, and requested them to give introductory lectures on one current subject each. One of the graduate students was assigned the task of writing up the notes. The Fields medalist Laurent Schwartz, known for his theory of Distributions, was one of the invitees. The notes taker

of his lectures was Narasimhan. This proved to be fortuitous, for Schwartz was impressed with the keenness and ability of Narasimhan as well as a few other graduate students. When he returned to France, he persuaded some of his students, like Jacques Lions, Bernard Malgrange, etc. to visit TIFR and give courses. On his visit, Lions suggested a problem connected with the limits of partial differential operators on Manifolds, and Narasimhan solved the question in the affirmative.

KC soon realized the high quality of the graduate students and felt that there was no one to mentor them in India. Consequently, with the help of Schwartz, he delegated Narasimhan, among a couple of others, to visit France for a few years and work on such topics. In Paris, Narasimhan came in contact with a Japanese graduate student, Keisuke Kotake, and proved a nice result on Elliptic operators, in collaboration with him.

Unfortunately however, he contracted pleurisy while in Paris and had to be hospitalized. He looked upon it, not as a disaster, but as an opportunity to be with ‘real Parisians’. He also told me that his spoken French improved manyfold as a consequence.

On his return to India, he obtained his doctorate and soon was appointed Associate Professor. It is remarkable that he could start advising students for their doctorate in turn so early in his career.

I was then a graduate student at TIFR and Narasimhan warmed up to me when he came to know that I was conversant with the work of Kodaira and Spencer. I became his first student and we soon wrote up a paper, ‘Universal Connections’ where we proved that the classifying space for principal bundles with compact structure group also had a connection which was universal for bundles with connections, as well. This was very well received, and later became useful for many developments in differential geometry as well as theoretical physics.

Seshadri and he jointly wrote a few papers in which the theory of vector bundles over a smooth projective algebraic curve was the main thrust and soon it culminated in what is now known as

‘the Narasimhan–Seshadri theorem’. This gave a deep understanding of the classification of vector bundles over curves and led to many later developments. Narasimhan occupied himself with the study of the moduli space so constructed, and it was my good fortune to have worked jointly with him in this enterprise.

A distinguishing feature of Narasimhan’s research was his ability to catch on to any question, even if in an area where he had, a priori, no expertise, bring new ideas to the problem and solve it. He would fill in the details later, sometimes running a seminar on the topic. This explains the versatility of his research work, and his propensity to collaborate with different types of mathematicians, from young graduate students to famous achievers. Thus apart from his work with Indian colleagues like Ramadas, Seshadri, Simha and myself, he also worked jointly with Kotake (as I have mentioned above), Harder, Beauville, Hirschowitz, Lange, Okamoto and a host of others. Many of these researches spawned new directions and are still of value, decades later. But even more remarkable is that these collaborations span a wide area including Number theory, Differential equations, Differential geometry, Lie groups, Algebraic geometry and even Theoretical physics.

Apart from mathematics, he had other interests too. He liked Modern Art, particularly Impressionism, thanks to his French connection. He was also fond of books. We used to frequent the Strand Book Stall and buy books. He liked to read contemporary Tamil books. Even after he retired and settled in Bengaluru, he tried to time his visits to Chennai in order to buy books at the Annual Tamil Book Fair.

On the administrative side, he became the first chairman of the National Board for Higher Mathematics and introduced many initiatives. It has now become the principal funding agency for mathematical research. Around 1990, after decades of research and mentoring, he decided to join the International Centre for Theoretical Physics in Trieste and worked for over ten years as the head of its mathematical division. There he mentored students which, he mentioned to me, gave him great satisfaction as he always

wished to make some contribution to third world science.

He returned to India in the late 90's. Although he had retired, he was full of ideas pertaining to the moduli space and its generalizations. Apart from mathematics, he was interested in Carnatic music and as I mentioned above, in modern Tamil literature as well. However, his deep interest in mathematics never waned. A few months after he had contracted the cursed disease, he wrote to

me that our work had new ramifications and that they are now talking about 'Narasimhan–Ramanujan branes'! He even helped a student of Oscar Garcia-Prada, our Spanish friend with some ideas, very close to his final days.

Fortunately, his stature did not go unrecognized, in India as well as internationally. He was awarded Padma Vibhushan, the Bhatnagar Prize and was a Fellow of all the three science academies of India. He was elected Fellow of the

Royal Society, the Chevalier d'Ordre du merite of France, the Abdul Kalam prize and so on.

I am fortunate to have been his close friend till his very end.

S. RAMANAN

*Chennai Mathematical Institute,  
Chennai 603 103, India  
e-mail: sramanan@cmi.ac.in*

## Gade Padmanabham (1964–2021)

Gade Padmanabham, Director, International Advanced Research Centre for Powder Metallurgy and Newmaterials (ARCI), Hyderabad was born on 10 August 1964. He pursued B.E. in Mechanical Engineering from Andhra University, Visakhapatnam and M.Tech. in Industrial Metallurgy at National Institute of Technology-Warangal. He worked on metal-ceramic joining and weldability of Al–Li alloys at IIT-Delhi and Technical University, Dresden, as German Academic Exchange Service-DAAD Fellow, earning Ph.D. from IIT-Delhi.

Padmanabham started his career as Deputy Manager with Bharat Dynamics Ltd, Hyderabad in 1987 and worked on indigenization of materials for strategic products. He joined Department of Science and Technology (DST) as Scientist-C in 1990 and became Scientist-G in 2006. He dealt with implementation of National Superconductivity programme, intelligent processing of materials and superconductor-based magnetic resonance imaging materials. As a Nodal Officer, he coordinated establishment of Indo-Soviet Advanced Research Centre for Powder Metallurgy. He steered international joint S&T programmes in the areas of engineering materials, electronic materials, applied mechanics, etc., with Belarus, Germany, Israel, Japan, Sweden and Switzerland for R&D, including doctoral/post-doctoral fellowships in Japan and Germany. His efforts ensured engagement of Indian scientists for working on ultra high voltage transmission electron microscopy, photon factory and super photon ring in Japan. Other such initiatives led to creation of Centre for

Laser Processing of Materials with Israel and use of mega research facilities at National Laboratory for High Energy Physics, Spring-8 Accelerators and Construction of Indian beam line in Japan. He leveraged his contacts in Germany for the benefit of Indian researchers in using state-of-the-art facilities at German Electron Synchrotron, Berlin Electron Storage Ring Society, Facility for Antiproton and Ion Research, besides launching



DST-DAAD Personnel Exchange Program, DST–German Research Foundation Cooperation and DST–Max Planck partnership in niche areas, interaction of young Indian scientists with Nobel Laureates in Lindau, etc., in Germany.

Padmanabham did pioneering work on laser processing of materials, sol–gel nanocomposite coatings, carbon materials, etc. His contributions transformed the Laser Centre of ARCI as a unique facility for addressing complex problems through robotic brazing, high precision welding, micromachining and additive manufacturing for application in automotive, aer-

ospace, nuclear, power, defense and electronics sectors. The group led by him developed transparent ceramics and also successfully transferred infra red dome technology for strategic sector. He reoriented the sol–gel nanocomposite group focusing on solar selective coatings, anti-tarnish coatings, architectural coatings and corrosion-resistant coatings. His foray into carbon materials perfected different techniques of producing carbon nanotubes, and successfully integrated with the laser group in achieving high field emission properties for strategic applications, a unique attempt proved successful at the field level. He conceptualized and implemented multi-institutional consortia projects, involving IITs, original equipment manufacturers of automotive components, Fraunhofer Institutes of Germany and private entities in developing a unique technique that combined laser welding and cold metal transfer brazing for tailor welded blanks and multi-material lightweight components. His concerted efforts resulted in development of silica-based aerogel sheets for insulation applications, sol–gel nanocomposite coatings for coloured glass, zinc sulphide infra red transparent ceramics for strategic applications and nanotitania for self-cleaning applications, with superior quality and close tolerances as compared to other processes. He and his team perfected many processes and transferred the same to a few enterprises.

After taking over as Director of ARCI in 2016, Padmanabham provided overall leadership for successful development of technologies in the fields of engineering materials and additive manufacturing and