RESEARCH IN MATHEMATICAL SCIENCES IN INDIA*

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It is as much a faith as it is a fact that the creative
contributions of India in mathematics and mathematical sciences
in recent years are more in keeping with international standards
than in applied science and technology. I shall attempt a rapid
review of the growth of mathematical sciences in India during the
past sixty years starting with the solitary splendour of Ramanujan
to the present day when India is providing hundreds of young
emigrant mathematicians to the scientific establishments of Europe
and the United States. I shall conveniently divide the sixty years
into three periods - 1920-1945 the age of individual genius,
1945-1970 the Bhabha era of professionalism in science and 1970 to
the present day with a peep into the future of professional mathematics

Modern mathematics in India has a single starting point in
space and time, the work of Srinivasa Ramanujan in Madras in the
theory of numbers. He came out of nowhere at the dawn of this
century, just a phenomenon which burst and blazed forth a light of
such intensity as is still shining today with undiminished brilliance.
The fact that he was recognised even at school and at college clearly
showed that there was at that time an intellectual community capable
of understanding such creative work and estimating such mathematical
genius. However, unfortunately there was not at that time a group of
persons or institutions which could benefit directly by the presence
of such creative genius in the country. Today, number theory is no
longer an isolated discipline, for it has ramifications over all the
domains of modern mathematics. Ramanujan's contributions are
influencing the entire domain of mathematical development engaging
the attention of leading minds in centres like Harvard and Princeton,
Cambridge and Conttingen.

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During the period 1920-1945 there were honours and M.Sc. courses in Indian Universities demanding high standards of performance of students who were mainly qualifying themselves for the civil service and similar professions. Creative science attracted only a few individuals and there were no institutions sponsoring systematic research. Satyen Bose, Megnad Saha, Chandrasekhar, Bhabha and Harish-Chandra are perhaps shining examples of such individual effort. Chandrasekhar left for Cambridge and then migrated to Chicago; Harish-Chandra did much the same but taking to pure mathematics after reaching the United States. Besides these, of course there were many individual mathematicians like Vijayaraghavan, Ganapathi Iyer and Vaidyanathaswamy who carried on work in lonesome glory in their respective Universities.

It has to be accepted and emphasised that systematic research at doctoral and post-doctoral level in mathematical sciences started with the creation of the Tata Institute of Fundamental Research at Bombay by Professor Bhabha. His greatest contribution to Indian science was that for the first time in the annals of Indian society, mathematical sciences became a profession changing the entire face of Indian technological and economic development.

The Bhabha era started in 1945 at Kenilworth, a beautiful little private home in Peddar Road in Bombay, the initial venue of the Tata Institute of Fundamental Research. It was my privilege to be associated with the architect of Indian science at the inception of this great effort. Within two decades after the creation of the department of atomic energy, crores of rupees were spent on research in newly constructed gigantic establishments and the Tata Institute received its full share of support from the Government of India. It was the good fortune of the Indian mathematician Chandrasekharan to join the Institute when the tide of support for basic research was at its peak. With his organising ability he was able to attract the best of talent towards mathematics in the Tata Institute of Fundamental Research.

During the past twenty five years that Institute has produced about a dozen first rate mathematicians, the name of Raghavan Narasimhan standing out prominently for his great contributions to complex variable theory. However the output of doctorates in quantity has been too small and the range of interests too narrow to make any impact on the technological and economic development of our country. It was soon realised that there was a need for Institutions for higher research in mathematics in other parts of the country. Some were created within the Universities as centres of advanced research as in Chandigarh and Madras while the Institute of Mathematical Sciences was started in Madras independent of the Universities. An expanding community of professional mathematicians with doctorate degree is emerging from these centres. It was to be seen whether these mathematicians will be needed by industry in India and or whether they will seek opportunities in the more affluent institutions in the United States.

In the realm of statistics, India produced a personality as impressive and pervasive as that of Professor Bhabha. Professor Mahalonobis was the founder of the Indian Statistical Institute in the early 1930s; He was particularly fortunate in his early students - Professor C.R.Rao, R.C.Bose and S.N.Roy who became statisticians of world-wide reputation. While two of them migrated to the United States, C.R.Rao remained in India making fundamental contributions to this day and carrying forward the message and spirit of Mahalonobis. India has been particularly strong in statistics and many a time I have been asked what the favourable factors were for this predilection towards statistics.

Though statistics has been a favourite profession, the study of stochastic processes has been confined to only a few groups in our country. It was my privilege to be associated with the famous British mathematical statisticians Professors Bartlett and Kendall in the 1950s and I was able to train a band of Ph.D. students in Madras following my own work, a summary of which was published in the Handbuch der Physik in 1956. It is gratifying that one of my distinguished colleagues Professor Vasudevan is carrying out a vigorous programme of research with the eminent mathematician

Professor Dick Bellman of California on the application of mathematical methods to biological and medical sciences. Other centres for work on stochastic processes are the Indian Institute of Technology in Madras and the Annamalai University.

In the domain of theoretical physics Bhabha's contributions stand out supreme in India during the past thirty years. There has been no original contribution from an Institution within India comparable with that of Bhabha's work during the past few decades. The period has been the golden age of Physics in America with an uninterrupted flow of Nobel Prize winning ideas from physicists like Feynman and Gellman, Bethe and Schwinger. Institutions within India have produced a broad spectrum of competent middle class physicists who provide effective support to the experimental groups in the country. At Matscience we were able to complete a comprehensive programme on matrix theory inspired by Bhabha's own particular leanings towards the subject.

In applied mathematics the story is about the same. Though there have been active schools under persons like B.R.Seth and P.L.Bhatnagar in the Institute of Technology, there are not many applied mathematicians of world stature. In the realm of astro-physics Chandrasekhar's name shines in unique glory and there seems to be a very little interest in Indian universities in astrophysical problems. A beginning has been made to support the experimental group in radio astronomy with theoreticians and only the future can unfold whether we will have an effective group or not in the astrophysical sciences.

Thus surveying the entire scene in India we must confirm our belief that it is only in the realm of pure mathematics that India made great strides with Harish-Chandra as the leading light of our times. Very recently I had the opportunity to meet him at work in his spacious and comfortable room in the Institute for Advanced Study over looking the luscious lawns and the verdant environment of that famous centre of learning where Einstein found his haven and Oppenheimer propagated his ideas. Today Harish-Chandra is reckoned among the greatest mathematicians of the world like Weil, Selberg, Erdos, Grothendick and Serre. Watching him I felt very optimistic about

India's future role in mathematical sciences. What we need today is just a stimulating atmosphere of competitive research to foster the genius that already exists in our country. A few suggestions would be relevant which if taken seriously would help in creating such an atmosphere.

1. A fraction of the staff in graduate colleges should hold research degrees. Adequate facilities should be provided for research-minded staff to participate in conferences and seminars.

2. Active scientists from outside should be invited to deliver weekly seminars at colleges and universities.

3. Organisation of annual symposia where the work from research institutions should be actively compared and discussed.

4. Provision of adequate funds for research workers to present papers and participate in an International conferences.

5. Travelling fellowships within India to stimulate competition and friendly cooperation.

If out of a vacuum India has produced Ramanujan, Chandrasekhar and Harish-Chandra, can we not foresee the magnitude of the possibilities if a suitable environment is provided for the discovery and encouragement of such talent all over the country?