

Beyond Ramanujan: India in Twentieth Century

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The gigantic leap in the twentieth century mathematics was the outcome of two major events. The first belonged to the historic Presidential keynote address by the celebrated German mathematician Prof David Hilbert at the second international Congress in Paris in 1900. His address, at the foothill of the 20th century, propounded a list of twenty three outstanding problems (conjectures) that hid the course of future world mathematics. In fact these problems that had cast the tone for hectic mathematical activities and researches comprising the 20th century consisted of - the famous continuum hypothesis, the Riemann hypothesis, the well-ordering theorem, the solvability of a Diophantine equation, the transcendence of powers of algebraic numbers etc. According to Minkowski, (the great algebraist and topologist) - these bundle of problems 'took a total lease on the 20th century world mathematics'.

On the way of efforts for solving, each of these problems set the vistas for new divergent areas of mathematics. Hilbert himself was a migratory bird flying high of several mathematical domains and pointed out the breeding spots to other mathematical frogs. The inspiring activities of the investigators led the 20th century mathematics to abstraction, axiomatisation and topical foundation. These are materialized in Hilbert's famous work-the 'Foundation of Geometry (1899) that was the first attempt for removing the flows in the erstwhile prevailing Euclidean geometry and also laying the foundation of the non-Euclidean's. Of course during the early part of the century there were a plenty of brush-fine debates on the issues of the foundations of the pure mathematics. At this centre of hot furnace, the main battlers were Felix Klein, Kart Schwarzschild and some others in the research community in Gottingen (German) and few other European centres. In spite of this various facets of pure and applied researches with modern wings were still continued in different centres of learning that included Gottingen itself, Cambridge, Princeton etc. This race for new generation of mathematics spread wide and far to different countries including India by then math-physicists. Now they were blown out to their modernization in pure form.

The second event that largely contributed to framing the course of twenty century mathematics was the upcoming (Nicolas) Bourbaki group of mathematicians in French in 1930. Bourbaki not only unified and compartmentalized the entire mathematical structures but also published out a series of elaborate mathematical text books which established the basic ground for higher researches for the next fifty years. These books are vividly descriptive and submersed in generalized abstraction in style formerly introduced by Rene Descartes, the fence and the inventor of Cartesian co-ordinate system and Francis Bacon in England in 17th century. Bourbaki books embraced all that existing mathematics in modern pure and abstract form and it is said that 'what is not in these text books and concrete examples are not mathematics' (Freeman Dyson).

Mathematics in India observed considerable retrogradation after the twelve century great mathematician Bhaskara which continued till the latter part of nineteenth century. In fact for several hundred years there existed a long vacuum of formidable mathematicians of comparable stature. Thereafter appeared Ramanujan (1887-1920), the remarkable mathematical prodigy of the 20th century. Ramanujan possessed uncanny manipulative ability in number forms and functional relations. His remarkable works are

attributed in the fields of infinite series number theory, especially of partitions, continued fractions, integrals, theory of elliptic, modular and mock-theta functions and etc. With Hardy and Littlewood at Cambridge and thereafter Ramanujan published nearly twenty-six significant papers in various European journals and twelve papers in journal of Indian mathematical society, apart from leaving aside hundred of curious solved and unsolved problem, conjectures and formulae. Details of these can be ascertained from the Ramanujan's 'Note books' published by Madras University and TIFR. To gauge his talent and outstanding ability with profound and invincible originality it is enough to quote Hardy that- 'I have never met his equal and I can compare him only with Euler and Jacobi. European mathematicians will take fifty years to decipher what is contained in his note books.' According to R. Ramachandran- 'aura of Ramanujan was so versatile that it has virtually eclipsed other Indian mathematicians.'

During the post-Ramanujan era in the twentieth century a considerable amount of mathematical researchers were by many Indian striders inside and outside the country. Many of them followed Ramanujan's tradition. However the state of the art in mathematics upto the fourth decade was in a sway and the western wave of new mathematics was prevailing at ebb and flow. Indian researches mostly centered on analysis and number theory following traditional works of Ramanujan and Cambridge. Gradually Indian mathematical doors were opened to the diversification of world mathematic. Anyhow Indian mathematics gave vent to the doors of high degree of formal abstraction and logical approaches to all fields towards the second part of 20th century, particularly in the fields of Algebra, analysis, geometry and topology. These seeds of modernization were contributed by contemporary in respective fields such as Felix Klien, Karl Schwarzschild, D. Hilbert, Richard Courant (German, Americans), G. H. Hardy, Littlewood (England), Abraham Besicovitch (Russian), G.D. Birkhoff, R.L. Moore, Zorn etc (USA), John Bolyai (Hungary), Henri Poincare (French) etc. Many of them were migratory birds fixing their eyes on the roots of mathematics elsewhere. At Princeton (USA) the Institution for advanced study, Einstein, Weil (German) Gödel (Czechoslovakia) etc invented the tremendous laws of nature by applying powerful tools and beauties of mathematics. These all happened to be the inspiring source for Indian researchers.

Few contemporary eminent mathematicians of Ramanujan's era were- Prof. Ganesh Prasad (1876-1935) of Allahabad (Ballia, U.P); K. Ananda Rau (1893-1966) from Madras and his disciples, R. Vaidyanathswamy (1894-1960) from Madras, B.S. Pillai (1901-1950) from Tinunelveli (TN) and a host of others.

Professor B. N. Prasad

Both Ganesh Prasad and Ananda Rau were scholars at Cambridge. Prasad's research was on spherical harmonics, potential theory, Bessels Functions etc. At Gottingen he worked with alumni like Hobson, Forsyth, Klien, Sammerfield, Hilbert, Cantor etc during his five years stay at London and Germany. Ananda Rau, a friend of Ramanujan kept his research around Hardy, but unlike that of Ramanujan he was much conventional. He completed his math tripos from King's college, Cambridge in 1916. His work in number theory, divergent series etc fetched him the coveted 'Smith Prize' (1917). After returning from England Rau contributed largely to Riemann Zeta function, Tauberian Theory, elliptic functions etc. He must be remembered for his work on the famous Waring's problem (i.e representation of integers as sums of higher powers) which was later solved by Balasubramanian (1986) in collaboration with his two French counterparts.

The majority in the galaxy of South Indian mathematicians in the post-Ramanujan era were in fact the

student of Ananda Rau. They include S.S. Pillari, T.Vijayaraghavan (1902-1955) of Chennai, S. Minakhsundaram (1913-1968) of Thissur, S.Chawla (1907-1995) from Lahore and K.Chandrashekharan (1920) of Aundhra Pradesh . All of them mostly followed Ramanajun tradition and worked along Anand Rao's line where number theory continued to be an integral part of their research theme.

R. Vaidyanathswamy worked with Professors H.W. Twrnbull, E.T. Whittaker and H.F. Baker of UK on Binary from pedal correspondence etc. After returning to India he contributed mostly to symbolic logic, modern algebra and topology. Prof B.N. Prasad worked in Liverpool and Paris with the celebrated mathematicians E.C. Titchmarsh and A.Denjoy in the areas of Real variable. S.S. Pillai carried out research in number theory (75 papers), logic, algebra and topology under the guidance of Anand Rau and Vaidyanathswamy. He worked on Waring problem. Professor C.T. Rajagopal (Director of Ramanajun institute of Mathematics) contributed largely to the summability theory and complex functions. Another genius was Prof P.L. Bhatnagar. He was a forerunner of Plasma Physics in India. Prof. S. Chawla worked under Littlewood at Cambridge and he was also associated with Institute of Advanced studies in Princeton. He contributed as many as 350 research paper on Number theory. Prof V. Ganapati Iyer also contributed largely to Analysis (Real, complex and functional) and topology. A physicist, Prof. P.C. Mahalanolis (1893-1972) was a famous statistician of India. The ISI at Calcutta was his brain-child.

Harish Chandra

Harish Chandra (1923-1983) is another reputed mathematician who worked in the fields of Algebra and Analysis. Prof D.R. Kaprekar (1905-1988) from Thana (near Bombay) contributed mainly to recreational number theory. He is best known outside India especially for his invention of Kaprekar's constant '6174', self -numbers, demlo-numbers, cycles of recurring etc.

Several brilliant Indians had passed the Cambridge Tripos. From them few had won the senior wangership and few had the glory of winning the coveted Smith and other prizes. Out of them, an outstanding mathematician of our country is Dr. V.V. Narlikar. Dr. Narlikar (1908-1991) is from Maharashtra and was a wrangler by clearing mathematical Tripos in Cambridge. He also won the Tyson medal, Smith prize, Rayleigh prize for his outstanding works in general relativity.

To name few other doyens of Indian mathematicians during the early part of 20th century include Prof Ram Behari (1897-1981), S.N. Bose (1894-1074), B.N. Prasad (1899-1966), B.S. Madhaba Rao (1900-1987), P.K. Menon (1917-1979), Ram Ballabh (1918-1976), L.G. Saithe and so on.

For a systematic development and detail achievements of our mathematicians after Ramanujan for all the five decades many literature are already published, especially from R.M.S. Chennai. Some collected works of S.S. Pillai, R.Vaidyanathaswamy etc also reflects the chronology of Indian mathematics. Indian Mathematical Society was born in Madras in 1907 and two years later it founded its first journal "Journal of Indian Mathematical Society". Consequently in 1933 the Indian statistical journal named 'Sankhya' began its publication. Till now IMS is holding its conferences annually. This sequence is delivering a mathematics revolution to the growth of Indian maths and the torch-bearing problems of the end part of 19th century brought the sparkling down of the 20th century.

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