NEWS AND VIEWS

CHRIS SAILS, ND

Srinivasa Ramanujan

Background: Srinivasa Aiyengar Ramanujan was one of India's greatest mathematical geniuses. He made substantial contributions to the analytical theory of numbers and worked on elliptic functions, continued fractions, and infinite series.

Ramanujan was born on December 22, 1887 at his grandmother's house in Erode, a small village about 400 km southwest of Madras, in Tamil Nadu State, India. When Ramanujan was a year old his mother took him to the town of Kumbakonam, about 160 km nearer Madras. His father worked in Kumbakonam as a clerk in a cloth merchant's shop. In December 1889 he contracted smallpox.

When he was nearly five years old, Ramanujan entered the primary school in Kumbakonam although he would attend several different primary schools before entering the Town High School in Kumbakonam in January 1898. He started school in an English medium being that India was a British colony at that time and education was organized along the English system.

As a student he was a slow learner in all subjects except in mathematics. He excelled in math. In fact his teachers could not keep up with him. At this time, he came across a book written by G.S. Carr, Synopsis of Results in Pure and Applied Mathematics, which greatly affected his life as it provided him the information that he was looking for. In 1904, he was given a scholarship to Kumbakonam government college. He became very obsessed with mathematics and everything else became insignificant to him. This caused him to neglect other subjects at the college and he failed his term and could not graduate from the university. He also lost the scholarship. He did not have a job, no money and now no scholarship either. But his passion for mathematics grew many fold. Following that he spent a few years wandering around and concentrating on mathematical work on his own.

In 1906 Ramanujan went to Madras where he entered Pachaiyappa's College. His aim was to pass

the First Arts examination which would allow him to be admitted to the University of Madras. He attended lectures at Pachaiyappa's College but became ill after three months study. He took the First Arts examination after having left the course. He passed in mathematics but failed all his other subjects and therefore failed the examination. This meant that he could not enter the University of Madras. In the following years he worked on mathematics developing his own ideas without any help and without any real idea of the then current research topics other than that provided by Carr's book.

Continuing his mathematical work Ramanujan studied continued fractions and divergent series in 1908. At this stage he became seriously ill again and underwent an operation in April 1909 after which it took him some considerable time to recover. He married on 14 July 1909 when his mother arranged for him to marry a ten year old girl S Janaki Ammal. Ramanujan did not live with his wife, however, until she was twelve years old. His marriage brought him back to reality of facing responsibility of taking care of his wife. He looked for a job where he could earn enough money to live and permit time to work on his interest -Mathematics.

Without money he was soon in difficulties and, without telling his parents, he ran away to the town of Vizagapatnam about 650 km north of Madras. He continued his mathematical work, however, and at this time he worked on hypergeometric series and investigated relations between integrals and series. He was to discover later that he had been studying elliptic functions.

Ramanujan continued to develop his mathematical ideas and began to pose problems and solve problems in the *Journal of the Indian Mathematical Society.* He developed relations between elliptic modular equations in 1910. After publication of a brilliant research paper on Bernoulli numbers in 1911 in the *Journal of the Indian Mathematical Society* he gained recognition for his work. Despite his lack of a university education, he was becoming well known in the Madras area as a mathematical genius.

In 1911 Ramanujan approached the founder of the Indian Mathematical Society for advice on a job. After this he was appointed to his first job, a temporary post in the Accountant General's Office in Madras. It was then suggested that he approach Ramachandra Rao who was a Collector at Nellore. Ramachandra Rao was a founding member of the Indian Mathematical Society who had helped start the mathematics library.

Ramachandra Rao liked this young man and helped him find a job where he also had plenty of time to work on mathematics. He helped him grow in many areas.

Ramanujan was quite lucky to have a number of people working round him with a training in mathematics. In fact the Chief Accountant for the Madras Port Trust, S N Aiyar, was trained as a mathematician and published a paper *On the distribution of primes* in 1913 on Ramanujan's work. The professor of civil engineering at the Madras Engineering College C L T Griffith was also interested in Ramanujan's abilities and, having been educated at University College London, knew the professor of mathematics there, namely M J M Hill. He wrote to Hill on 12 November 1912 sending some of Ramanujan's work and a copy of his 1911 paper on Bernoulli numbers.

The University of Madras gave Ramanujan a scholarship in May 1913 for two years and, in 1914, he traveled to Trinity College, Cambridge, to begin an extraordinary collaboration. Setting this up was not an easy matter. Ramanujan was an orthodox Brahmin and so was a strict vegetarian.

Ramanujan sailed from India on 17 March 1914. It was a calm voyage except for three days on which Ramanujan was seasick. He arrived in London on 14 April 1914. After four days in London he went to Cambridge and Ramanujan spent a couple of weeks in his friend Neville's home before moving into rooms in Trinity College on 30th April. Right from the beginning, however, he had problems with his diet. The outbreak of World War I made obtaining special items of food harder and Ramanujan began having on-going health problems related to diet and the cold weather (Winter) in England.

On 16 March 1916 Ramanujan graduated from Cambridge with a Bachelor of Science by Research (the degree was called a Ph.D. from 1920). He had been allowed to enrol in June 1914 despite not having the proper qualifications. Ramanujan's dissertation was on

Highly composite numbers and consisted of seven of his papers published in England.

Ramanujan fell seriously ill in 1917 and his doctors feared that he would die. He did improve a little by September but spent most of his time in various nursing homes.

On 18 February 1918 Ramanujan was elected a fellow of the Cambridge Philosophical Society and then three days later, the greatest honor that he would receive, his name appeared on the list for election as a fellow of the Royal Society of London. He had been proposed by an impressive list of mathematicians, namely Hardy, MacMahon, Grace, Larmor, Bromwich, Hobson, Baker, Littlewood, Nicholson, Young, Whittaker, Forsyth and Whitehead. His election as a fellow of the Royal Society was confirmed on 2 May 1918, then on 10 October 1918 he was elected a Fellow of Trinity College Cambridge, the fellowship to run for six years.

The honors which were bestowed on Ramanujan seemed to help improve his health a little and he renewed his efforts at mathematics. By the end of November 1918 Ramanujan's health had greatly improved.

Ramanujan sailed to India on 27 February 1919 arriving on 13 March. However his health was very poor and, despite medical treatment, he died there the following year.

Ramanujan left a number of unpublished notebooks filled with theorems that mathematicians have continued to study. G N Watson, Mason Professor of Pure Mathematics at Birmingham from 1918 to 1951 published 14 papers under the general title *"Theorems stated by Ramanujan"* and he published nearly 30 papers which were inspired by Ramanujan's work. Hardy passed on to Watson the large number of manuscripts of Ramanujan that he had, both written before 1914 and some written in Ramanujan's last year in India before his death.

CONCLUSION

Ramanujan's years in England were mathematically productive and he gained the recognition he hoped for. Cambridge granted him a Bachelor of Science degree "By Research" in 1916, and he was elected a Fellow of the Royal Society (the first Indian to be so honored) in 1918. But the unaccustomed culture, weather, living habits, unavailability of proper food (he was a strict vegetarian and it was during War time) took a toll on his health. Ramanujan had always lived in a warm climate and had his mother to cook for him; later his wife did the cooking. In England, he was forced to live in the English winter, he had to do all his own cooking to maintain the dietary rules of his caste. Wartime shortage for particular type of foods made the situation worse. In 1917, he was very ill and hospitalized, by late 1918 his health improved. He returned to India. He died on April 26, 1920 in Kumakonam.

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