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Little-known Facts About Srinivasa Ramanujan

Personal Background

Srinivasa Ramanujan was an Indian mathematician who lived from 1887 to 1920. He was born on December 22, 1887, in Erode, India, but grew up in Kumbakonam, where his parents were clerks at a merchant's shop. Ramanujan's mathematical ability was evident from an early age, and he is known for making significant contributions to several areas of mathematics, particularly number theory.

Most mathematicians have an extensive math background or lineage, but Ramanujan was different. He was a self-taught mathematician who learned mathematics through books and his own intuition. By the age of 12, Ramanujan had mastered S. L. Loney's *Plane Trigonometry*, and by 15, he had borrowed G. S. Carr's *A Synopsis of Elementary Results in Pure Mathematics* from the local Government College Library. The style and content of the latter influenced Ramanujan for the next decade, namely due to the text's lack of detailed proofs. Specifically, the text contains statements of about 5000 theorems and notions with only brief sketches of proofs. In about 1903, Ramanujan began to record his mathematical discoveries without significant proofs in notebooks.

In his final year at the Town Higher School of Kumbakonam, Ramanujan took the matriculation exam of the University of Madras and obtained a "first-class" place in mathematics. In 1903, he entered the Government College at Kumbakonam, which is known as the "Cambridge of South India" because of its impressive academic standards. However, Ramanujan was only interested in math and failed all other classes. Eventually, Ramanujan attempted university once more in Madras around 1906, but he was again unsuccessful for the same reason. It is claimed that his parents were quite upset about this outcome, and eventually, Ramanujan ran away from his home for a couple of months. During this time, his parents were worried and even put out ads to locate his whereabouts. It is widely known that following his second

failed attempt at college, Ramanujan worked in isolation and devoted himself completely to mathematics while recording his findings in his personal notebooks.

In 1909, Ramanujan married Janaki and was therefore encouraged to seek employment. At the time of his marriage, Janaki was only nine years old, which is quite unorthodox in today's world. In 1912, he obtained a position as a clerk in the Madras Port Trust Office. The chairman, Sir Francis Spring, and the manager, S. N. Aiyar, who was also a well-known and talented Indian mathematician, took great interest in Ramanujan. They encouraged him to write some English mathematicians about his discoveries. At first, his attempts to contact European mathematicians were unsuccessful, but on January 16, 1913, he wrote G. H. Hardy, which led to one of the most important collaborations in mathematics. In response to Ramanujan's letter, Hardy mentioned, "I had never seen anything in the least like them before. A single look at them is enough to show that they could only be written down by a mathematician of the highest class. They must be true because, if they were not true, no one would have had the imagination to invent them."

Ramanujan was invited to study under Hardy, but he faced several objections due to the customs of Brahmins at that time. Specifically, there was a belief that if he crossed the seas, he would be considered defiled and wouldn't be able to attend religious events such as weddings and funerals in the future. To overcome such objections, Ramanujan went to a significant temple and got permission from the family goddess, Namagiri, the Hindu goddess of creativity, after spending three days there. After overcoming the family objections, Ramanujan accepted Hardy's invitation to come to Cambridge and departed from India on March 17, 1914. Ramanujan's time in Cambridge was productive, and he worked closely with Hardy. Together, they published several papers on various topics, including number theory, continued fractions, and the partition function.

After three years at Cambridge, Ramanujan was infected with an unknown disease. He spent two years in nursing homes before returning back to India. When he came back, Ramanujan was invited to become a professor at Banaras Hindu University. Due to the illness, he responded, saying he would accept

the offer when his health was better. However, Ramanujan's illness was not cured, and he passed away on April 26, 1920, at the age of 32.

Interesting Facts from Bruce Berndt's Interview

Bruce Berndt is an American mathematician with an extensive knowledge of Ramanujan's background and mathematical results. There are several lesser-known facts about Ramanujan that were described in Berndt's article "Ramanujan 100 Years Old (Fashioned) or 100 Years New (Fangled)?" and his interview with Professor Stoyan Dimitrov.

Berndt had the chance to speak with Ramanujan's wife, Janaki, twice, and he was able to communicate with her through her adopted son Narayan. According to Berndt, Janaki was always extremely excited when talking about Ramanujan, and she even had a sculpture of him. Moreover, according to Janaki, Ramanujan was "always doing his sums" (a euphemism for doing his mathematical work) up until just four days before he passed, which shows how dedicated he was to his passion. Moreover, Janaki lived until the age of 95, but she did not remarry as it was frowned upon in India at that time. In addition, when in India, Ramanujan lived with his wife and mother, which shows how close he was to his mother in particular. Finally, according to Berndt, Ramanujan's first words to Janaki when he came back to India were that he should have taken her to England with him. He believed that if Janaki had been with him to cook and take care of him, he would not have had bad eating and sleeping habits. Despite the illness, Janaki told Berndt that Ramanujan considered his time in England to be the best thing that ever happened to him and that he had no regrets. England, and Hardy in particular, were what gave him the opportunity to study mathematics more seriously, and despite the unfortunate health circumstances, he valued the experience greatly.

Mathematical Results

Ramanujan is responsible for many notable discoveries in mathematics. In particular, he has had several notable results in mathematical analysis, infinite series, continued fractions, number theory, and game theory. Many of his results are not easily digestible for the common mathematical audience as it involves extremely complex mathematical theory. For instance, some of his notable complex discoveries

include his work with theta functions as well as his work with G.H. Hardy on the circle method. Simply put, Ramanujan's theta function generalizes the form of the previous Jacobi theta functions. It is used to determine the critical dimensions in Bosonic string theory, superstring theory, and M-theory. Hardy's and Ramanujan's circle method gave the first approximations of the partition of numbers beyond 200. This method also contributed to solving complex problems of the 20th century, such as Waring's conjecture.

Although there were several complicated results, there were some that were interesting and more digestible for the average mathematical audience. One example is the Hardy-Ramanujan Number. When Ramanujan was in the hospital, Hardy visited him, and along the way, he took a taxi cab, number 1729. Hardy was superstitious, and he claimed that 1729 seemed to him an unlucky number. Accordingly, he hoped his superstitious perception was wrong and that his friend would get well soon. In response, Ramanujan replied immediately by saying that 1729 is a very interesting number as it is the smallest number which can be expressed as the sum of cubes of two numbers in two different ways as shown: 1729 = 1^3 +12^3 = 10^3 + 9^3. Another interesting conclusion from Ramanujan was his work regarding Goldbach's conjecture. The conjecture states every even integer > 2 is the sum of two primes. For instance, 6=3+3. Ramanujan was able to prove that every large integer could be written as the sum of at most four (Example: 43=2+5+17+19). While the proof is complicated, it highlights the types of problems Ramanujan found interesting and chose to spend his time on. Finally, he was able to find an approximation for pi which was accurate and more concise than previous approximations, as shown. Ramanujan's formula takes one formula to calculate up to 6 decimal places, yet it takes Leibniz about 5 million terms. Ramanujan's formula could do it in one term though and each successive term adds up another 8 decimal places to the value of π. Also, mathematicians use this formula today to find the value of π to an insurmountable extent.

$$\frac{1}{\pi} = \frac{2\sqrt{2}}{9801} \sum_{k=0}^{\infty} \frac{(4k)!(1103 + 26390k)}{(k!)^4 396^{4k}}$$

$$\pi = \frac{9801}{1103\sqrt{8}}$$

Conclusion

Srinivasa Ramanujan was a brilliant Indian mathematician who made significant contributions to several areas of mathematics, particularly number theory. Despite being a self-taught mathematician who

learned mathematics through books and his own intuition, Ramanujan was able to master complex mathematical concepts and record his discoveries in his personal notebooks. He faced many obstacles throughout his life, including failing university and dealing with his illness, but he overcame them and continued to pursue his passion for mathematics. Overall, Ramanujan's life and legacy continue to inspire mathematicians and people around the world.

Works Cited

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Interview Between Professor Stoyan Dimitrov & Bruce Berndt

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