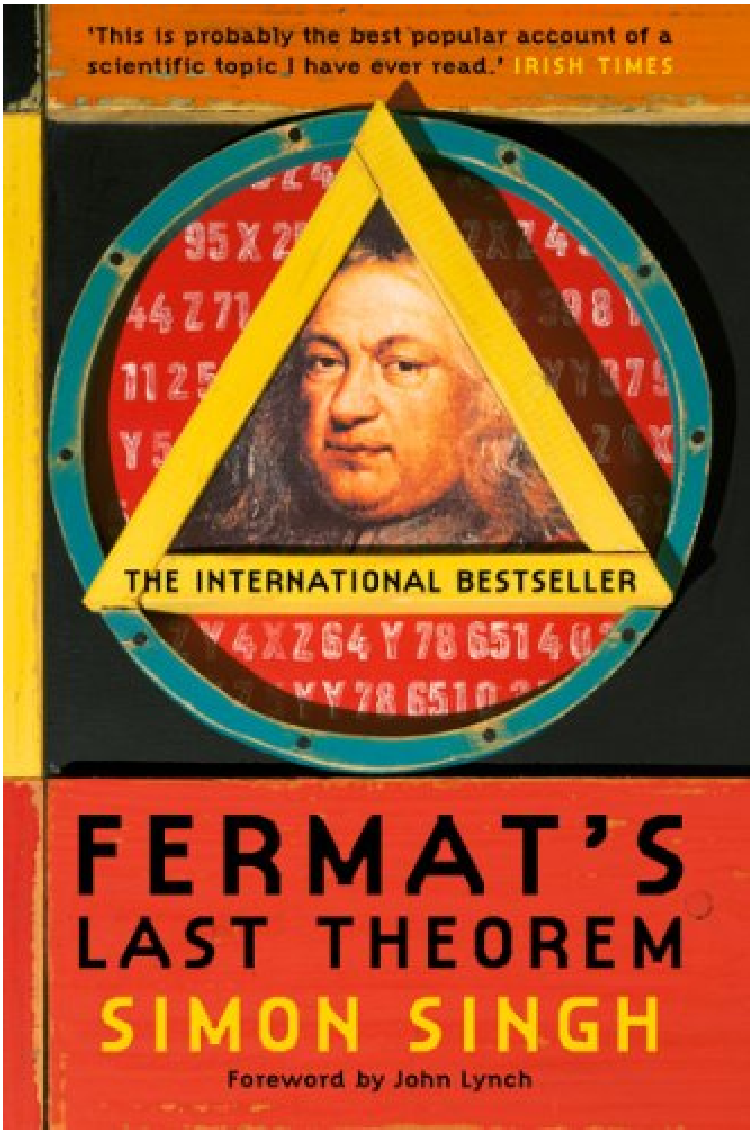
# Fermats Last Theorem






*Par Simon Singh*
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**Par Simon Singh : Fermats Last Theorem** before purchasing it in order to gage whether or not it would be worth my time, and all praised Fermats Last Theorem:

**Description :**

Prsentation de l'diteurI have a truly marvellous demonstration of this proposition which this margin is too narrow to contain.It was with these words, written in the 1630s, that Pierre de Fermat intrigued and infuriated the mathematics community. For over 350 years, proving Fermats Last Theorem was the most notorious unsolved mathematical problem, a puzzle whose basics most children could grasp but whose solution eluded the greatest minds in the world. In 1993, after years of secret toil, Englishman Andrew Wiles announced to an astounded audience that he had cracked Fermats Last Theorem. He had no idea of the nightmare that lay ahead.In Fermats Last Theorem Simon Singh has crafted a remarkable tale of intellectual endeavour spanning three centuries, and a moving testament to the obsession, sacrifice and extraordinary determination of Andrew Wiles: one man against all the odds.Extrait"I Think I'll Stop Here"Archimedes will be remembered when Aeschylus is forgotten, because languages die and mathematical ideas do not. "Immortality" may be a silly word, but probably a mathematician has the best chance of whatever it may mean.--G. H. HardyJune 23, 1993, CambridgeIt was the most important mathematics lecture of the century. Two hundred mathematicians were transfixed. Only a quarter of them fully understood the dense mixture of Greek symbols and algebra that covered the blackboard. The rest were there merely to witness what they hoped would be a truly historic occasion.The rumors had started the previous day. Electronic mail over the Internet had hinted that the lecture would culminate in a solution to Fermat's Last Theorem, the world's most famous mathematical problem. Such gossip was not uncommon. The subject of the Last Theorem would often crop up over tea, and mathematicians would speculate as to who might be doing what. Sometimes mathematical mutterings in the senior common room would turn the speculation into rumors of a breakthrough, but nothing had ever materialized.This time the rumor was different. When the three blackboards became full, the lecturer paused. The first board was erased and the algebra continued. Each line of mathematics appeared to be one tiny step closer to the solution, but after thirty minutes the lecturer had still not announced the proof. The professors crammed into the front rows waited eagerly for the conclusion. The students standing at the back looked to their seniors for hints of what the conclusion might be. Were they watching a complete proof to Fermat's Last Theorem, or was the lecturer merely outlining an incomplete and anticlimactic argument?The lecturer was Andrew Wiles, a reserved Englishman who had emigrated to America in the 1980s and taken up a professorship at Princeton University, where he had earned a reputation as one of the most talented mathematicians of his generation. However, in recent years he had almost vanished from the annual round of conferences and seminars, and colleagues had begun to assume that Wiles was finished. It is not unusual for brilliant young minds to burn out, a point noted by the mathematician Alfred Adler: "The mathematical life of a mathematician is short. Work rarely improves after the age of twenty-five or thirty. If little has been accomplished by then, little will ever be accomplished." "Young men should prove theorems, old men should write books," observed G. H. Hardy in his book A Mathematician's Apology. "No mathematician should ever forget that mathematics, more than any other art or science, is a young man's game. To take a simple illustration, the average age of election to the Royal Society is lowest in mathematics." His own most brilliant student, Srinivasa Ramanujan, was elected a Fellow of the Royal Society at the age of just thirty-one, having made a series of outstanding breakthroughs during his youth. Despite having received very little formal education in his home village of Kumbakonam in South India, Ramanujan was able to create theorems and solutions that had evaded mathematicians in the West. ln mathematics the experience that comes with age seems less important than the intuition and daring of youth.Many mathematicians have had brilliant but short careers. The nineteenth-century Norwegian Niels Henrik Abel made his greatest contribution to mathematics at the age of nineteen and died in poverty, just eight years later, of tuberculosis. Charles Hermite said of him, "He has left mathematicians something to keep them busy for five hundred years," and it is certainly true that Abel's discoveries still have a profound influence on today's number theorists. Abel's equally gifted contemporary *variste Galois also made his breakthroughs while still a teenager.Hardy once said, "I do not know an instance of a major mathematical advance initiated by a man past fifty." Middle-aged mathematicians often fade into the background and occupy their remaining years teaching or administrating rather than researching. In the case of Andrew Wiles nothing could be further from the truth. Although he had reached the grand old age of forty he had spent the last seven years working in complete secrecy, attempting to solve the single greatest problem in mathematics. While others suspected he had dried up, Wiles was making fantastic progress, inventing new techniques and tools that he was now ready to reveal. His decision to work in absolute isolation was a high-risk strategy and one that was unheard of in the world of mathematics.Without inventions to patent, the mathematics department of any university is the least secretive of all. The community prides itself in an open and free exchange of ideas and afternoon breaks have evolved into daily rituals during which concepts are shared and explored over tea or coffee. As a result it is increasingly common to find papers being published by coauthors or teams of mathematicians, and consequently the glory is shared out equally. However, if Professor Wiles had genuinely discovered a complete and accurate proof of Fermat's Last Theorem then the most wanted prize in mathematics was his and his alone. The price he had to pay for his secrecy was that since he had not previously discussed or tested any of his ideas with the mathematics community, there was a significant chance that he had made some fundamental error.Ideally Wiles had wanted to spend more time going over his work and checking fully his final manuscript. But when the unique opportunity arose to announce his discovery at the Isaac Newton Institute in Cambridge he abandoned caution. The sole aim of the institute's existence is to bring together the world's greatest intellects for a few weeks in order to hold seminars on a cutting-edge research topic of their choice. Situated on the outskirts of the university, away from students and other distractions, the building is especially designed to encourage the academics to concentrate on collaboration and brainstorming. There are no dead-end corridors in which to hide and every office faces a central forum. The mathematicians are supposed to spend time in this open area, and are discouraged from keeping their office doors closed. Collaboration while moving around the institute is also encouraged--even the elevator, which travels only three floors, contains a blackboard. In fact every room in the building has at least one blackboard, including the bathrooms. On this occasion the seminars at the Newton Institute came under the heading of "L-functions and Arithmetic." All the world's top number theorists had been gathered together in order to discuss problems relating to this highly specialized area of pure mathematics, but only Wiles realized that L-functions might hold the key to solving Fermat's Last Theorem.Although he had been attracted by having the opportunity to reveal his work to such an eminent audience, the main reason for making the announcement at the Newton Institute was that it was in his hometown, Cambridge. This was where Wiles had been born, it was here he grew up and developed his passion for numbers, and it was in Cambridge that he had alighted on the problem that was to dominate the rest of his life.The Last ProblemIn 1963, when he was ten years old, Andrew Wiles was already fascinated by mathematics. "I loved doing the problems in school. I'd take them home and make up new ones of my own. But the best problem I ever found I discovered in my local library."One day, while wandering home from school, young Wiles decided to visit the library in Milton Road. It was rather small, but it had a generous collection of puzzle books, and this is what often caught Andrew's attention. These books were packed with all sorts of scientific conundrums and mathematical riddles, and for each question the solution would be conveniently laid out somewhere in the final few pages. But this time Andrew was drawn to a book with only one problem, and no solution.The book was The Last Problem by Eric Temple Bell. It gave the history of a mathematical problem that has its roots in ancient Greece, but that reached full maturity only in the seventeenth century when the French mathematician Pierre de Fermat inadvertently set it as a challenge for the rest of the world. One great mathematician after another had been humbled by Fermat's legacy, and for three hundred years nobody had been able to solve it.Thirty years after first reading Bell's account, Wiles could remember how he felt the moment he was introduced to Fermat's Last Theorem: "It looked so simple, and yet all the great mathematicians in history couldn't solve it. Here was a problem that I, a ten-year-old, could understand and I knew from that moment that I would never let it go. I had to solve it."Usually half the difficulty in a mathematics problem is understanding the question, but in this case it was straightforward--prove that there are no whole number solutions for this equation:xn + yn = zn for n greater than 2.The problem has a simple and familiar look to it because it is based on the one piece of mathematics that everyone can remember--Pythagoras's theorem:In a right-angled triangle the square on the hypotenuse is equal to the sum of the squares on the other two sides.Or: x2+ y2= z2Pythagoras's theorem has been scorched into millions if not billions of human brains. It is the fundamental theorem that every innocent schoolchild is forced to learn. But despite the fact that it can be understood by a ten-year-old, Pythagoras's creation was the inspiration for a problem that had thwarted the greatest mathematical minds of history.In the sixth century B.C., Pythagoras of Samos was one of the most influential and yet mysterious figures in mathematics. Because there are no firsthand accounts of his life and work, he is shrouded in myth and legend, making it difficult for historians to separate fact from fiction. What seems certain is that Pythagoras developed the idea of numerical logic and was responsible for the first golden age of mathematics. Thanks to his genius numbers were no longer merely used to count and calculate, but were appreciated in their own right. He studied the properties of particular numbers, the relationships between them, and the patterns they formed. He realized that numbers exist independently of the tangible world and therefore their study was untainted by the inaccuracies of perception. This meant he could discover truths that were independent of opinion or prejudice and that were more absolute than any previous knowledge.He gained his mathematical skills on his travels throughout the ancient world. Some tales would have us believe that Pythagoras traveled as far as India and Britain, but what is more certain is that he gathered many mathematical techniques from the Egyptians and Babylonians. Both these ancient peoples had gone beyond the limits of simple counting and were capable of performing complex calculations that enabled them to create sophisticated accounting systems and construct elaborate buildings. Indeed they saw mathematics as merely a tool for solving practical problems; the motivation behind discovering some of the basic rules of geometry was to allow reconstruction of field boundaries that were lost in the annual flooding of the Nile. The word itself, geometry, means "to measure the earth."Pythagoras observed that the Egyptians and Babylonians conducted each calculation in the form of a recipe that could be followed blindly. The recipes, which would have been passed down through the generations, always gave the correct answer and so nobody bothered to question them or explore the logic underlying the equations. What was important for these civilizations was that a calculation worked--why it worked was irrelevant.After twenty years of travel Pythagoras had assimilated all the mathematical rules in the known world. He set sail for his home island of Samos in the Aegean Sea with the intention of founding a school devoted to the study of philosophy and, in particular, concerned with research into his newly acquired mathematical rules. He wanted to understand numbers, not merely exploit them. He hoped to find a plentiful supply of free-thinking students who could help him develop radical new philosophies, but during his absence the tyrant Polycrates had turned the once liberal Samos into an intolerant and conservative society. Polycrates invited Pythagoras to join his court, but the philosopher realized that this was only a maneuver aimed at silencing him and therefore declined the honor. Instead he left the city in favor of a cave in a remote part of the island, where he could contemplate without fear of persecution.Pythagoras did not relish his isolation and eventually resorted to bribing a young boy to be his first pupil. The identity of the boy is uncertain, but some historians have suggested that his name was also Pythagoras, and that the student would later gain fame as the first person to suggest that athletes should eat meat to improve their physiques. Pythagoras, the teacher, paid his student three oboli for each lesson he attended and noticed that as the weeks passed the boy's initial reluctance to learn was transformed into an enthusiasm for knowledge. To test his pupil Pythagoras pretended that he could no longer afford to pay the student and that the lessons would have to stop, at which point the boy offered to pay for his education rather than have it ended. The pupil had become a disciple. Unfortunately this was Pythagoras's only conversion on Samos. He did temporarily establish a school, known as the Semicircle of Pythagoras, but his views on social reform were unacceptable and the philosopher was forced to flee the colony with his mother and his one and only disciple.Pythagoras departed for southern Italy, which was then a part of Magna Graecia, and settled in Croton, where he was fortunate in finding the ideal patron in Milo, the wealthiest man in Croton and one of the strongest men in history. Although Pythagoras's reputation as the sage of Samos was already spreading across Greece, Milo's fame was even greater. Milo was a man of Herculean proportions who had been champion of the Olympic and Pythian Games a record twelve times. In addition to his athleticism Milo also appreciated and studied philosophy and mathematics. He set aside part of his house and provided Pythagoras with enough room to establish a school. So it was that the most creative mind and the most powerfu1 body formed a partnership.Secure in his new home, Pythagoras founded the Pythagorean Brotherhood--a band of six hundred followers who were capable not only of understanding his teachings, but who could add to them by creating new ideas and proofs. Upon entering the Brotherhood each follower had to donate all his worldly possessions to a common fund, and should anybody ever leave he would receive twice the amount he had originally donated and a tombstone would be erected in his memory. The Brotherhood was an egalitarian school and included several sisters. Pythagoras's favorite student was Milo's own daughter, the beautiful Theano, and, despite the difference in their ages, they eventually married.Soon after founding the Brotherhood, Pythagoras coined the word philosopher, and in so doing defined the aims of his school. While attending the Olympic Games, Leon, Prince of Phlius, asked Pythagoras how he would describe himself. Pythagoras replied, "I am a philosopher," but Leon had not heard the word before and asked him to explain.Life, Prince Leon, may well be compared with these public Games for in the vast crowd assembled here some are attracted by the acquisition of gain, others are led on by the hopes and ambitions of fame and glory. But among them there are a few who have come to observe and to understand all that passes here.It is the same with life. Some are influenced by the love of wealth while others are blindly led on by the mad fever for power and domination, but the finest type of man gives himself up to discovering the meaning and purpose of life itself. He seeks to uncover the secrets of nature. This is the man I call a philosopher for although no man is completely wise in all respects, he can love wisdom as the key to nature's secrets.Although many were aware of Pythagoras's aspirations, nobody outside of the Brotherhood knew the details or extent of his success. Each member of the school was forced to swear an oath never to reveal to the outside world any of their mathematical discoveries. Even after Pythagoras's death a member of the Brotherhood was drowned for breaking his oath--he publicly announced the discovery of a new regular solid, the dodecahedron, constructed from twelve regular pentagons. The highly secretive nature of the Pythagorean Brotherhood is part of the reason that myths have developed surrounding the strange rituals that they might have practiced, and similarly this is why there are so few reliable accounts of their mathematical achievements.What is known for certain is that Pythagoras established an ethos that changed the course of mathematics. The Brotherhood was effectively a religious community, and one of the idols they worshiped was Number. By understanding the relationships between numbers, they believed that they could uncover the spiritual secrets of the universe and bring themselves closer to the gods. In particular tbe Brotherhood focused its attention on the study of counting numbers (1, 2, 3, ...) and fractions. Counting numbers are sometimes called whole numbers, and, together with fractions (ratios between whole numbers), they are technically referred to as rational numbers. Among the infinity of numbers, the Brotherhood looked for those with special significance, and some of the most special were the so-called "perfect" numbers.According to Pythagoras, numerical perfection depended on a number's divisors (numbers that will divide perfectly into the original one). For instance, the divisors of 12 are 1, 2, 3, 4, and 6. When the sum of a number's divisors is greater than the number itself, it is called an "excessive" number. Therefore 12 is an excessive number because its divisors add up to 16. On the other hand, when the sum of a number's divisors is less than the number itself, it is called "defective." So 10 is a defective number because its divisors (1, 2, and 5) add up to only 8.The most significant and rarest numbers are those whose divisors add up exactly to the number itself, and these are the perfect numbers. The number 6 has the divisors 1, 2, and 3, and consequently it is a perfect number because 1 + 2 + 3 = 6. The next perfect number is 28, because 1 + 2 + 4 + 7 + 14 = 28.As well as having mathematical significance for the Brotherhood, the perfection of 6 and 28 was acknowledged by other cultures who observed that the moon orbits the earth every 28 days and who declared that God created the world in 6 days. In The City of God, St. Augustine argues that although God could have created the world in an instant he decided to take six days in order to reflect the universe's perfection. St. Augustine observed that 6 was not perfect because God chose it, but rather that the perfection was inherent in the nature of the number: "6 is a number perfect in itself, and not because God created all things in six days; rather the inverse is true; God created all things in six days because this number is perfect. And it would remain perfect even if the work of the six days did not exist."As the counting numbers get bigger the perfect numbers become harder to find. The third perfect number is 496, the fourth is 8,128, the fifth is 33,550,336, and the sixth is 8,589,869,056. As well as being the sum of their divisors, Pythagoras noted that all perfect numbers exhibit several other elegant properties. For example, perfect numbers are always the sum of a series of consecutive counting numbers. So we have6 =1+2+3,28 =1+2+3+4+5+6+7,496=1+2+3+4+5+6+7+8+9+ . . . +30+31,8,128 =1+2+3+4+5+6+7+8+9+ . . . +126+127.Pythagoras was entertained by perfect numbers, but he was not satisfied with merely collecting these special numbers; instead he desired to discover their deeper significance. One of his insights was that perfection was closely linked to "twoness." The numbers 4 (2x2), 8 (2 x2 x 2), 16 (2x 2 x 2x 2), etc., are known as powers of 2, and can be written as 2n, where the n represents the number of 2's multiplied together. All these powers of 2 only just fail to be perfect, because the sum of their divisors always adds up to one less than the number itself.Revue de presse"An excellent account of one of the most dramatic and moving events of the century."--Sir Roger Penrose, New York Times Book "It is hard to imagine a more gripping account of...this centuries-long drama of ingenious failures, crushed hopes, fatal duels, and suicides."--Jim Holt, The Wall Street Journal"Though Singh may not ask us to bring too much algebra to the table, he does expect us to appreciate a good detective story." --Boston Sunday Globe"The history of mathematics comes alive even for those who dread balancing their checkbooks." --Publishers Weekly"Singh captures the joys and frustrations of this quest for an extremely elusive proof...and builds to a truly engrossing climax. It's a mathematical page-turner."--Library Journal