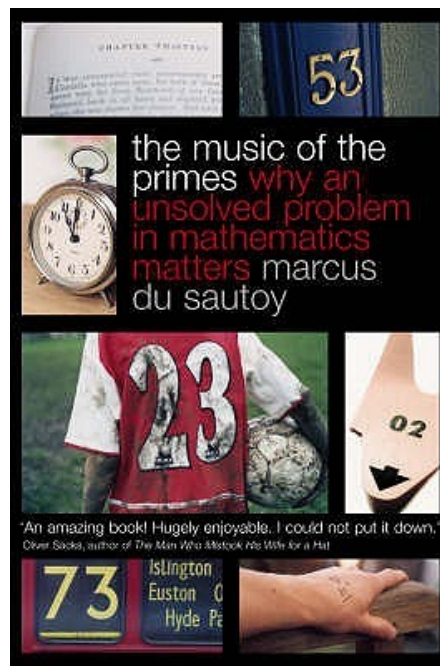




The Music of the Primes

Marcus du Sautoy

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A history of mathematics from the cutting-edge of present-day research, this tells the story of the most idiosyncratic and most fundamental numbers in pure mathematics, the primes. When counting, primes (numbers only divisible by one and themselves) appear without any reason or rhythm. To a non-mathematician this may seem an oddity. To scientists the key to this seeming randomness, called the Riemann Hypothesis, is one of the most important enigma within Mathematics.

The Music of the Primes Details

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From Reader Review The Music of the Primes for online ebook

Elisa Ferrarese says

Un libro coinvolgente ed affascinante su uno degli aspetti più intriganti della matematica, quello della dimostrazione dell'ipotesi di Reimann.

Il mistero dei numeri primi, così potentemente legati all'essenza stessa della realtà, è capace di avvincere chi è già appassionato di matematica, e forse in grado di far innamorare della matematica chi a scuola non l'ha mai amata.

Di certo questo è il più bel libro sulla matematica che abbia mai letto, racconta l'appassionante storia della matematica, fatta di scoperte e progressi che viaggiano da un capo all'altro del mondo, ma soprattutto la storia di matematici, grandi uomini che competono per arrivare oltre i confini della conoscenza e personaggi spesso affascinanti: Euclide, Gauss, Riemann, Ramanujan, Weil... quanto vorrei poter parlare per un momento con loro!

Per quanto la matematica possa sembrare una disciplina astratta, la sua storia è composta da avvenimenti avvincenti e spesso imprevedibili. E così forse l'incuria di una domestica crea una lacuna nella conoscenza che nemmeno le menti più brillanti degli ultimi due secoli non sono riuscite a colmare. O un matematico indiano cresciuto nel totale isolamento dalla comunità scientifica riesce a percorrere a suo modo un lungo cammino nella storia matematica, mentre un incontro quasi fortuito all'ora del tè getta luce sulla connessione tra i numeri e la fisica quantistica.

Questo libro mi è stato relegato da un caro amico recentemente scomparso. L'ho letto nel 2005 e l'ho riletto nel 2012. In entrambe le occasioni mi ha donato ore di puro piacere in compagnia delle menti più geniali dell'umanità e di una disciplina che ha saputo emozionarmi ed entusiasmarmi.

Remo says

Fantástico libro que narra la (hasta ahora inacabada) épica aventura de la hipótesis de Riemann. Una de las mejores cosas que puede tener un libro es provocar el deseo de saber más sobre un tema, en mi opinión. Y con este libro me he apuntado muchas, muchísimas cosas para luego indagar más. Eso es algo que le agradezco mucho al autor. Comenzamos poco a poco aprendiendo cómo el ministro de educación prusiano, Wilhelm von Humboldt, transformó el sistema educativo del país para dar más cancha a las ciencias básicas, justo cuando nuestro joven Riemann se incorporaba al sistema educativo. Seguimos la vida de Riemann, que comienza a mezclarse con las de Gauss, Euler, Hilbert y una plétora de matemáticos (¡y físicos!) que han contribuido esfuerzos encaminados a la resolución de la hipótesis de Riemann. El relato es fantástico y solo he echado de menos en alguna ocasión un poco más de detalle por parte del autor. Pero la intensidad del relato es mucha y mantiene mucho el interés. Es soberbio.

Una cosa que no me ha gustado es el abuso que hace a veces el autor de la analogía. Es difícil divulgar sobre matemáticas, y más sobre matemáticas complejas como la teoría de números. Hay que encontrar un equilibrio entre lo demasiado simple y lo demasiado farragoso. Pero al autor, a veces, se va no ya por lo simple sino por lo incomprensible. Cuando habla de la intersección no nula de los números primos y la física cuántica, hace una analogía con "una tambor cuántico", que no queda del todo clara. Pero a partir de ese momento sólo hablará de físicos y matemáticos diversos que investigan sobre tambores cuánticos, así sin comillas. ¿Tambores cuánticos? ¿No podría el autor definir algo más en serio, aunque fuera una vez, a qué se refiere exactamente con un tambor cuántico, y luego ya seguir con la analogía? Otra de estas analogías son las "calculadoras de reloj", que usa sin comillas a lo largo de todo el libro para referirse a la aritmética modular. Como en un reloj de 12 horas $9+4$ o es 13 sino 1 (y así nos introduce la aritmética modular),

cualquier referencia posterior a la aritmética modular la traviste de calculadoras de reloj. Son dos analogías sobreutilizadas que recuerdo que no me gustaron. En cualquier caso, nadie ha dicho que sea fácil divulgar ideas tan complejas. Su punto de equilibrio entre lo preciso y lo comprensible para el público está un poco más escorado que el mío.

En cualquier caso, es un libro fantástico que deja con ganas de más. Imprescindible.

Fiona says

How do I love Marcus du Sautoy? Let me count the ways.

Nicked this off my dad during my A levels, ended up buying my own copy and taking it to university because I wanted to lend it out to people without him getting upset. It's accessible, broad and fascinating - perfect for the enthusiastic amateur and armchair mathematician.

For the record, you may write "enthusiastic amateur" on my tombstone.

Jafar says

Well, aren't prime numbers really fascinating? If you're rolling your eyes, then you should read this book.

The main subject of the book is the Riemann Hypothesis. You have to be patient if you don't know what it is. It takes about 100 pages of the book to get to the point where it (sort of) tells you what it is. There's a particular complex function called zeta function. The zeros of this function can be used to correct a formula by Gauss that approximates the number of prime numbers less than any integer N . The hypothesis is that all these zeros have a real part of $\frac{1}{2}$. Isn't that fascinating? No? Not yet? Something must be wrong with you.

The Riemann Hypothesis has become the most famous unsolved problem in math. There's a one million dollar prize on it, but don't quit your job to work on it because the geniuses-among-geniuses of mathematics have failed to crack this problem for 150 years. This book tells their story. There's a lot of great math history in the book, plus a lot of number theory tidbit that I found fascinating (seriously). Du Sautoy is a great writer.

And don't tell me, Who cares about prime numbers, dude? Your internet encryption works based on modulo calculations on large prime numbers. Thank to them, you can enter your credit card numbers, knowing that even if someone intercepts the data it will be completely useless to them. Also, prime numbers can make you some money – and I'm not talking about the million dollar prize on the Riemann Hypothesis. C.I.A. will pay you 10,000 dollars for every prime number that is 100 digits or larger. Not bad, huh? And there are more 100-digit prime numbers than atoms in the entire known universe. Good luck finding one!

kartik narayanan says

I love maths and books on math. But this book just plain bored me to tears. I made it halfway through and could not find any reason to continue.

Huw Evans says

Prime numbers are unique; they can only be divided by themselves and the number one. They crop up irregularly as you count upwards and are seemingly wholly unpredictable in their occurrence. There is an infinite number of them and they appear to be as important in life, the universe and everything as the numbers in the Fibonacci series.

There seems to be an inherent need in mathematics to rationalise and predict with a level of accuracy that goes beyond the normal. Only if the sun can be proved to have risen every day for an infinite number of days will a mathematician be happy to tell you that the sun rises. He may not be able to tell you why it rises or what the impact of its rising is but he will be happy to tell you that, under certain circumstances, it will rise every morning.

In 1859 Bernard Reimann published his hypothesis on prime numbers; that the real part of any non trivial zero of the Riemann zeta function is $1/2$. It was apparently proven by Riemann himself but the proof was never found, reportedly burned by his housekeeper when tidying up after his death. Since then many mathematicians have devoted their efforts to providing enough evidence that this is true. Even with the advent of supercomputers and the finding of prime numbers with a million digits, which still fulfil the hypothesis, it has not been proven satisfactorily. Attempts to disprove it have been equally unsuccessful by not finding a single prime number that doesn't behave in this way.

So far, so good. I am not a mathematician and, even now, I could not explain to you the derivation and use of a zeta function - there may be none for all I know. This is a book as much about mathematicians as it is about their subject matter, and they are every bit as fascinating. These are people who are so driven by the abstract that they seem to want to find the rules that govern even the most random events using a language that has evolved in huge leaps to the point of being unrecognisable by ordinary men.

Marcus de Sautoy speaks clearly throughout this book and the mathematics is not overpowering. In fact I found the most interesting section was the application of prime number mathematics to internet security and cryptography. At the end of the book, I confess, no mathematical light had clicked on in my head and some of even the most basic stuff left me puzzled but, overall, this is an impressive, erudite and coherent read.

Gabigabigabi says

The main idea of the book is the Riemann hypothesis. The book begins with the story of the primes. It recounts the main characters, who have contributed with respect to Riemann hypothesis.

The Riemann hypothesis, regarded as the most important unsolved problems not only in mathematics but the whole science .

This is an important book for me.

Occhionelcielo says

Cito testualmente, o quasi:

"L'ipotesi di Riemann, l'ultimo teorema di Fermat, la congettura di Goldbach, .. sono tutte scoperte che hanno reso immortali i matematici responsabili di aver dissepolto quei tesori nel corso dell'esplorazione dei numeri primi.

I loro nomi sopravviveranno quando ormai ci saremo dimenticati da tempo quelli di Eschilo. Goethe e Shakespeare" .

Bill Ward says

This book was at its heart a biography of the Reimann Hypothesis, and of the mathematicians who worked on trying to prove or disprove it over the years. I really liked the way that it showed the relationships among the people involved, and how the centers of number theory research shifted from Paris to Göttingen to Princeton, and how this was caused in large part by the geopolitics of the area (Napoleon and Hitler in particular).

But this book has a serious flaw. The math was really dumbed down for this book, with very little attempt to teach any of the concepts involved beyond vague metaphors. I feel that this would be frustrating for anyone with a real interest in math and number theory, and that the topic itself would be of little interest to people without the mathematical background, so I wish the author had given us a little more credit for our math skills (he is a professor of mathematics, so I know he could do it).

I suppose in conjunction with a real math book, this could give some interesting insights into the history of our understanding of prime numbers, but I felt ultimately that the lack of real math in the book made it a lot less enjoyable and informative than it could have been.

BlackOxford says

Natural Religion

If there is advanced technological life elsewhere in the universe, it would unlikely be Christian, or Muslim, or Jewish, or Buddhist. It would however certainly know the same mathematics that we do. And it would understand the phenomenon of the prime numbers and their significance as much as, perhaps more than, we do. Mathematics is the natural religion of the cosmos; and prime numbers are its central mystery.

Prime numbers are those integers which can only be divided without remainder by themselves (or of course by 1). Put another way, as du Sautoy does, prime numbers are the atoms from which all other numbers are composed. 1, 2, 3, and 5 are prime. 4 is merely 2×2 ; and 6 is 2×3 . 10 is 2×5 . Prime numbers constitute the periodic table of mathematical elements which can be mixed and matched to form molecules and compounds of enormous size and complexity.

Prime numbers become less frequent as numbers get larger. There are fewer in any interval greater than let's say 1000, than the same interval less than 1000. This is intuitively obvious since the greater the number the more lesser numbers there that might be divided into it evenly. Interestingly, there is always at least one

prime between any number and its double.

The fun arises because although mathematicians know primes occur less and less frequently as we progress up the scale of numbers, no one knows how to predict when the next one will be encountered. They can be, and have been, calculated to very large numbers indeed, but they can't be anticipated, only recognised once they appear.* Or should the term be 'revealed'?

Is it any wonder that prime numbers can take on an almost cultic significance? The 18th century philosopher, Denis Diderot, hated both religion and mathematics for the same reason. Both, he felt, provided a veil that obscured reality. Much of today's popular aversion to mathematics may well be down to this same associative prejudice: if something isn't immediately obvious or somewhat abstract, it is merely an unverifiable belief or theory and not worthy of respectable thought.

There is a good reason for the religious, even spiritual, interpretation of mathematics - particularly number theory, and especially prime numbers. In the first instance, unlike any other area of human inquiry - even theology - the results obtained in mathematics never change. Euclid's proofs may be superseded by more general analysis but they are nevertheless entirely correct and need no modification in a world of radically different cosmology and technology.

Mathematics also shares another characteristic with religion: a concern with aesthetics. Religion orders the world. It provides comprehensibility in a world that might appear otherwise chaotic. And order is an essential component of beauty. Mathematicians not only investigate order as beauty, they collectively insist upon it in their evaluation of their work. A proof or a theorem just isn't acceptable if it is ugly. The liturgy and art of the Roman Church has no advantage over the aesthetic wonder of the Euler Identity, which connects worlds even further apart than Heaven and Earth.

And, it must be said in an era of fake news and rootless factoids, there is nothing quite so practical as a good theory. And mathematics has the best theories - in astronomy, encryption, communications, and logistics to name some of the most obvious areas that are dependent upon them. In fact understanding almost anything at all reported in the press or online demands familiarity with at least the most glaring abuses of mathematical logic.

Not all of us, naturally, have the talent or discipline to become mathematicians. But most of us can appreciate the importance of history without being historians, or of engineering without building bridges. The real value of *The Music of the Primes* is that it inspires an appreciation of, and therefore interest in, the thought and thinkers that are perhaps the purest examples we have of shared human thought; who knows, perhaps cosmic thought. Mathematics - and its heroes like Euler, Gauss and Reimann, and Cauchy, and Godel - belong to all of humanity not just some sect. I find this inspiring. It is more than music; but music will do.

*The search for ever larger prime numbers continues. Here is the latest discovery:
<http://www.independent.co.uk/news/sci...>

Chik67 says

E finalmente, cribbio!

...un libro di divulgazione matematica che non mi torce le budella.

Lo so, sono rompipalle quando si parla di matematica perchè ho una idea tutta mia dei perchè e dei percome.

Inevitabile. Però qui, correttamente, la biografia delle persone è importante ma non travalica mai la discussione del problema matematico, le spiegazioni bilanciano bene precisione e divulgazione (su di un tema difficilissimo) e il vaggio è lungo e dettagliato, senza necessità di creare un intreccio da romanzo nei punti in cui, inevitabilmente, non c'è.

E poi ci sono anche io.

Come? No, no, non mi cita. Ma sono a uno di quei seminari, verso la fine, davanti a un matematico geniale e infantile che squaderna le sue idee, in quarta fila, con la palpebra calante e un'idea che rimbalza tra le pareti semivuote del cranio: "lascia giù!".

Shadab Zafar says

Mathematicians feel like characters and the course of history feels like a fictional story beautifully woven by du Sautoy.

This is the story of an outcast, a loner, who in his ten paged paper made a little hunch. It, also is, a story of an indian clerk who believed that a goddess was responsible for his contributions to mathematics. The story of a city which was home to some of the greatest mathematicians. A story of how the atoms of arithmetic lie at the heart of modern e-business.

But most of all, this is the story of a problem, which, since its formulation in 1859 has baffled the greatest of minds - The Riemann Hypothesis.

Many have devoted their entire career in search for a solution, only to find nothing. Many loved it so much that they didn't want to die before a proof was presented. Many have gone crazy in the search, never to return back.

But the hypothesis still stands strong. Some believe its time has come while others feel that it'll survive its bicentenary. Some believe it is false where other think that it is true but unprovable.

The hypothesis, having originated from pure arithmetic, has found its way to quantum mechanics and chaos theory and a proof would have far reaching consequences.

If you have the slightest of interest in mathematics, this book is a must read.

Noel Bush says

I'm most grateful to this book for finally enabling me to understand the Riemann Hypothesis. My love for math was derailed in high school when I got in over my head, and ever since it's always such a pleasure for me to find something that can help me taste some of that world that I missed out on. This book does a wonderful job of taking you through the development of some very cool math by telling the stories of the people who made important discoveries. You get a very clear sense of how mathematics is like one enormous conversation spanning centuries. This may really be the most well-written book on mathematics that I've ever read, and I've been through quite a few. I learned a lot about many mathematicians I had only a passing knowledge of, such as those of the Göttingen school (now I want to take a trip there!). But most exciting of all for me was that I was able to follow along, from the earliest discoveries about prime numbers, right up through the latest work in this century...and although the book never gets technical, I truly feel like

the author pulled no punches in laying out the reality of what people have been going after, and why, for all these years.

Nina Tandon says

I really like the quote from Weber "When the globe is covered with a set of railroads and telegraph wires, this net will render services comparable to those of the nervous system in the human body, partly as a means of transport, partly as a means for the propagation of ideas and sensations with the speed of lightning." For me, having grown up with the internet and extant high-speed transportation systems, I was attracted to physiology because of the analogy I saw between the "outside" and "inside" worlds...it must have been amazing to build that analogy in reverse, through witnessing the creation of the world's first high-speed transportation and communication systems. It makes me wonder what pther such biological/technological analogies we are witnessing the creation of, that will be come obvious with coming years...

Des says

Wow, I am not mathematically inclined at all but this was a thrill to read. what a talent to bring complex mathematics and the prime numbers to more people. Thanks to Du Sautoy. This book enriched my life.

??? says

The Music of The Primes, a wonderful and amazing journey to the world of prime numbers and patterns

it was at the summer of 2009 when i was first introduced to the beauty and strength of the primes when the instructor asked us to implement some factorization problems in my second programming course, it was at that class where he shed a little light on the true beauty of primes talking about RSA encryption which is discussed in a late chapter of the book. almost one year later, i had the chance to dive deeper in the world of primes while studying Number Theory at another course, and what a world it was!

this book is concerned about prime numbers, exploring them .. and illustrating the most famous problems related to them. some of which were solved, and some remained unsolved till this day. the most famous problem of them all is The Riemann Hypothesis which is discussed all along the book due to its importance, struggles and implications it will have (if solved) on other problems, mathematics and other sciences like physics.

du Sautoy takes the reader into a long journey exposing the ideas of the greatest minds ever, starting from Fermat, moving to Gauss, Riemann, Gödel, the enigma code breaker and father of AI and computing Alan Turing .. and many many others.

Marcus is very good at clarifying scientific concepts, he explains the Riemann Hypothesis really well that you grasp the core of it even if you're not a mathematician. i remember i came across the Riemann Hypothesis before reading this book and i tried to understand it by reading its Wikipedia related articles several times, but without having the slightest of idea about it! not until i read this book i understood what it is really about and realized how big its potential is.

the book explores The Riemann Hypothesis which is mainly a problem of navigating the primes looking for a pattern.

this is a really great book, one of the best i ever read. and i gotta say, du Sautoy's books are better than his documentaries. which reminds me to watch the televised series of this book presented by du Sautoy :D

as written on the back of the book, "A book not to be put down"!
cheers!

Jishnu Bhattacharya says

The Music of the Primes is an amazing introduction to the Riemann hypothesis. I'm a bit biased here, since I like math, and have some idea about the subject matter. If you know a bit about prime counting, logarithms, modular arithmetic and quantum mechanics, you can't put this down. Even the people who don't like math might find it interesting, it is so well written. The language is lucid, and even complicated mathematical concepts are presented in a way that is easy to understand. In fact, he never uses the equation of the hypothesis, explaining everything through simple words. The only formula used is an amusing (view spoiler).

More than just the history of the hypothesis, this book is a journey through the development of modern mathematics, how ideas formed and spread, how world wars slowed down the breakthroughs and overall, how brilliant minds work. Strongly recommended for anyone who likes science, and has heard of the Riemann hypothesis!

Aaron Humphrey says

I was fascinated with prime numbers myself for years. Many of my classmates could (if they had been paying attention) attest to the fact that I spent much of my class time, in high school math and many university courses, factorizing random 7- and 8-digit numbers, often when I really should have been paying attention and taking notes. I had the primes up to at least 200 memorized. I often wondered if there were easier ways to factorize, and I'm still not convinced there are, though apparently there are easier ways to determine whether a number is prime or not. So this book pricked my interest immediately.

This book covers a lot of different topics about prime numbers, moving quickly into general statements and conjectures, and spends a lot of time at the heart of the prime number problem, the Riemann Hypothesis. It has something to do with a function (the Riemann zeta function) having an infinite number of zeroes on the complex plane, and whether those zeroes are all on the same line or not. The implications of this go over my head (I didn't get that far in complex analysis, sadly), but I gather that proving the Hypothesis could lead to, say, an easy way to generate prime numbers, and thus, potentially, an easy way to break RSA encryption.

It strikes about the right balance between the math and the mathematicians. One seldom thinks of how, for instance, the French Revolution or World War I impact the progress of mathematics (as opposed to, say, physics). As someone who's gone far enough in university math to understand most, if not all, of the

concepts in the book, I found it enlightening, though I am both filled with respect for the mathematicians who made the discoveries in the book and more certain I could never really be one of them. I remember seeing some kind of PBSish show on TV (in our hotel room in Orlando) about the Riemann Hypothesis, which was so overdramatized that it felt like "Behind The Math". It spent more time on the failures, the people whose careers were blighted by trying to prove the Hypothesis, not to mention John "Beautiful Mind" Nash's disastrous public breakdown while lecturing on the subject. I enjoyed this much more, but then, I'd rather read a nonfiction book than watch a documentary any day. Maybe not for the faint of math, though I can't really judge.

Baal Of says

Hidden behind this unfortunately ugly cover is a beautiful story about the Riemann Hypothesis and the mathematics around the prime numbers. During my first semester of college my Calculus professor tried to talk me into going into mathematics instead of computer science, and there is a part of me that regrets not having done so, but then I read a book like this, and realize that the minds behind these theorems and proofs are so far beyond anything I could ever hope to achieve that I'm humbled and relieved. Instead I can sit back and occasionally work through a book like this, vicariously enjoying the astonishment, frustration, and brilliance of those who think in these incredibly abstract and abstruse worlds. I loved learning about how the prime numbers tied into quantum theory, and of course I was already familiar with their importance in cryptography. Sautoy does an excellent job of delivering the history with plenty of mathematical depth, and revealing the humanity of the people behind those walls.

Andrea says

You are not going to believe that a book on a math subject would be hard to put down but this book is brilliantly written. I started reading this with doubts I would actually finish and I keep getting hooked into reading the next chapter and the next chapter. The author writes the whole book like this is THE GREATEST treasure hunt ever. He starts out by talking about the million dollar prize for the person who can prove Riemann's Hypothesis. Then he tells the story of how people discovered little pieces of the puzzle and how astonished they were by their discovery and even the reader is astonished. This book is written about the field of math but you don't have to understand everything about the subject to enjoy the book. It is written at a level that anyone can understand. I was intrigued by the title which seems to say that there is a connection between music and prime numbers. When I read the chapter that inspired the title I was literally floored. There really is a sound/frequency associated with each of these "magical" numbers that are the building blocks of every other number. The author compares prime numbers to the chemist's Periodic Table except that there are an infinite number of prime numbers. The author also explains how if you look at the prime numbers one way they look random, but if you look at them another way, they all line up. For those who like history, this reads like a story.
