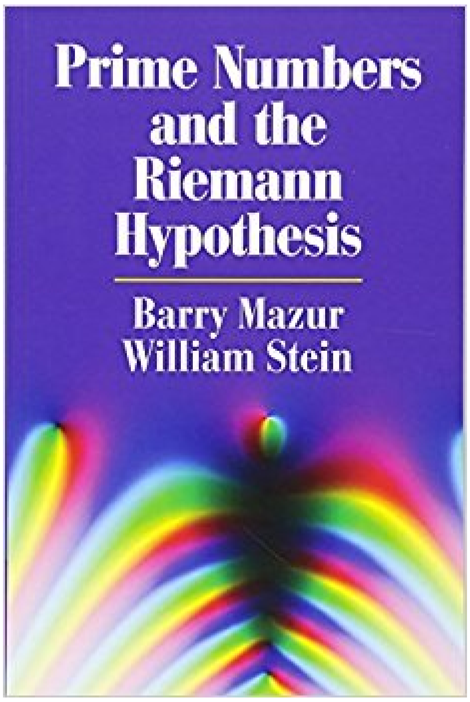
Prime Numbers And The Riemann Hypothesis



Synopsis

Prime numbers are beautiful, mysterious, and beguiling mathematical objects. The mathematician Bernhard Riemann made a celebrated conjecture about primes in 1859, the so-called Riemann Hypothesis, which remains to be one of the most important unsolved problems in mathematics. Through the deep insights of the authors, this book introduces primes and explains the Riemann Hypothesis. Students with minimal mathematical background and scholars alike will enjoy this comprehensive discussion of primes. The first part of the book will inspire the curiosity of a general reader with an accessible explanation of the key ideas. The exposition of these ideas is generously illuminated by computational graphics that exhibit the key concepts and phenomena in enticing detail. Readers with more mathematical experience will then go deeper into the structure of primes and see how the Riemann Hypothesis relates to Fourier analysis using the vocabulary of spectra. Readers with a strong mathematical background will be able to connect these ideas to historical formulations of the Riemann Hypothesis.

Book Information

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Customer Reviews

"This is an extraordinary book, really one of a kind. Written by two supreme experts, but aimed at the level of an undergraduate or curious amateur, it emphasizes the really powerful ideas, with the bare minimum of math notation and the maximum number of elegant and suggestive visuals. The authors explain why this legendary problem is so beautiful, why it is difficult, and why you should care." Will Hearst, Hearst Corporation"This book is a soaring ride, starting from the simplest ideas and ending with one of the deepest unsolved problems of mathematics. Unlike in many popular math books puffed up with anecdotal material, the authors here treat the reader as seriously interested in prime numbers and build up the real math in four stages with compelling graphical demonstrations revealing in deeper and deeper ways the hidden music of the primes. If you have ever wondered why so many mathematicians are obsessed with primes, here’s the real deal." David Mumford, Brown University, Rhode Island"This is a delightful little book, not quite like anything else that I am aware of ... a splendid piece of work, informative and valuable. Undergraduate mathematics majors, and the faculty who teach them, should derive considerable benefit from looking at it." Mark Hunacek, MAA Reviews’This book is divided into four parts, and succeeds beautifully in giving both an overview for the general audience and a sense of the details needed to understand how quickly the number of primes grows. This is accomplished through a very clear exposition and numerous illuminating pictures.’ Steven Joel Miller, MathSciNet’Where popularizers of mathematics usually succumb either to a journalist’s penchant for ’man bites dog’ irony and spectacle or a schoolteacher’s iron will to simplify away the terror, one might call the distinctive approach here ’take a lay reader to work’. Computers now provide mathematicians a laboratory, and the authors exploit this modern power to exhibit graphics, making the key equivalence a luminous phenomenon of experimental mathematics ... for its clarity and the importance of its topic, this book deserves the same classic status as A Brief History of Time (CH, Jul’88). Summing Up: Essential. All readers.’ D. V. Feldman, CHOICE

This book introduces the primes and explains the celebrated, unsolved Riemann hypothesis in a direct manner and with the least mathematical background required.

Good information for those with more or less math preparation, about a very deep topic.

Some good graphics and a good discussion of the Reimann spectrum. I found Derbyshire’s "Prime Obsession" overall more interesting and more accessible for the non-expert.

A couple of books on the Riemann hypothesis have appeared for the general public: Derbeshire 2003, Du Sautoiy 2003, Sabbagh 2003, Rockmore 2005, Watkins 2015, van der Veen and van der Craats 2015 and now Mazur-Stein 2016. More for mathematicians are Koblitz 1977, Edwards 2001, and Stopple 2003. From general expositions, one should also mention the paper of Conrey of 2003 which won the Conant prize for expository writing as well as a nice paper of Bombieri of 1992. Is this too much for the subject? No. A problem like the Riemann hypothesis can never be written too much about, especially if texts are written by experts. It is the open problems which drive mathematics. The Riemann hypothesis is the most urgent of all the open problems in math and like a good wine, the problem has become more valuable over time. What helped also is that since the time of Riemann, more and more connections with other fields of mathematics have emerged. The book of Veen-Craats and Mazur-Stein have emerged about at the same time. They are both small and well structured. Veen-Craats has been field tested with high school students and has focus mostly on the gorgeous Mangoldt explicit formula for the Chebychev prime distribution function, sometimes called the "music of the primes". Mazur-Stein do it similarly, however stress more on the Riemann spectrum and go didactically rather gently into the mathematics of Fourier theory as well as the theory of distributions. The book is carefully typeset, has color prints and some computer code for Sage. While Veen-Craats has many nice exercises, an exercise of Mazur-Stein led me to abandon other things for a couple of weeks, since it was so captivating. So be careful! A student who has taken basic calculus courses, should be able to read it. By the way, except Sabagh's book "Dr Riemann's zeros", which was written by a writer and journalist, the other books were created by professional mathematicians. The Mazur-Stein book has probably the best "street cred" among the RH books for the general audience: both have done important work in number theory, also related to zeta functions: Mazur's name is on one of the grand generalizations of the Riemann zeta functions, the Artin-Mazur zeta function which has exploded into a major tool under the lead of Ruelle who made it into a tool of dynamical systems and statistical mechanics. Other generalizations of zeta functions are spectrally defined and abundant in studies of differential geometry of a geometric space, one of the simplest cases being the circle, where it is the Riemann zeta function. Even other generalizations appear in algebraic geometry related to Diophantine equations and modular forms, where both authors, Mazur and Stein are leading experts working on the interplay between the analytic, geometric and number theoretic aspects of these functions. Additionally, Stein is the architect of the Sage computer algebra system. What distinguishes the book from the others? First of all, it is refreshingly short, gorgeous, inspiring and the publisher also kept it affordable. And since it can keep you caught, be prepared to shelf any other plans you might have while reading.

Excellent book and layered well for various levels of mathematical knowledge. Furthermore, the author has given a good sense in his exposition as to why this problem is interesting.

Prime Numbers and the Riemann Hypothesis by Barry Mazur and William Stein is a slender (142 pg.) book aimed at a varied audience of the mathematically curious. It is profusely illustrated, mainly with pictures of what the authors call the staircase of primes, a function that starts at zero and goes up by one each time a prime is encountered, though several recarpentried versions of the staircase also make the scene.The book is divided into 38 very short chapters, organized into four sections, with the first and longest section (chapters 1-24) aimed at readers without a calculus background. The second section demands a bit of calculus (not much!) and the third some Fourier analysis, while the fourth gets to the nitty-gritty of the zeta function.The figures and many of the calculations were done with Sage, a free mathware package developed by the second author, and made available to the eager experimenter.The first section has a lot of the lore primes that is accessible at the elementary level, and that is a great deal. How many consecutive primes, for example, are separated by two (3-5, 5-7, 41-43,...)? Nobody knows. How many are separated by an even number less than or equal to 246? That turns out to be known to be infinitely many.This isn't a textbook, and doesn't have problems, as such, but there are a few "you might try proving" suggestions. Here is the first one, a fairly good test of your basic algebra (or at least mine): A number of primes have the form 2^p - 1. Show that if p is not prime, then 2^p - 1 is composite (not prime). If that's too tough, try this: How many pairs of consecutive primes are separated by an odd number? ;-)Along the way, we meet several different incarnations of the Riemann Hypothesis, the first one being: For any real number X the number of prime numbers less than X is approximately Li(X) and this approximation is essentially square root accurate. Here Li(X) is the log integral of X = Integral[(1/Log(t))dt,]. (by Log we mean natural Log)Sections II and III of the book are devoted building up the apparatus needed to transform this statement into Riemann's form, which looks superficially very different: All the non-trivial zeroes of the zeta function lie on the vertical line in the complex plain consisting of the complex numbers with real part 1/2. These zeroes are (1/2 plus or minus i*theta(i)) where the theta(i) comprise the spectrum of primes talked about in the earlier chapters.Despite a good deal of verbiage devoted to the subject in the earlier chapters, I was never quite clear on exactly how these values are calculated, though I think that they are the Fourier transform of some version of the staircase of primes. I'd just like an equation that said theta(i) = some expression.

Very informative. Not for the professional who knows all about it already, of course.

Exceptional book that appeals to a non-mathematician and whet your appetite for more. Well written. The paperback binding is poor and the pages came out easily but a standard glue takes care of it easily.

Nicely written. Mazur is a good writer for popularizing mathematics.

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