

Heavenly Mathematics The Forgotten Art Of Spherical Trigonometry

The celebrated mathematician and philosopher Pythagoras left no writings. But what if he had and the manuscript had never been found? Where would it be located? Two mathematicians, one American, one British, set out, unbeknownst to each other, to find the missing manuscript.

At a time of unprecedented expansion in the life sciences, evolution is the one theory that transcends all of biology. Any observation of a living system must ultimately be interpreted in the context of its evolution. Evolutionary change is the consequence of mutation and natural selection, which are two concepts that can be described by mathematical equations. Evolutionary Dynamics is concerned with these equations of life. In this book, Martin A. Nowak draws on the languages of biology and mathematics to outline the mathematical principles according to which life evolves. His work introduces readers to the powerful yet simple laws that govern the evolution of living systems, no matter how complicated they might seem. Evolution has become a mathematical theory, Nowak suggests, and any idea of an evolutionary process or mechanism should be studied in the context of the mathematical equations of evolutionary dynamics. His book presents a range of analytical tools that can be used to this end: fitness landscapes, mutation matrices, genomic sequence space, random drift, quasispecies, replicators, the Prisoner's Dilemma, games in finite and infinite populations, evolutionary graph theory, games on grids, evolutionary kaleidoscopes, fractals, and spatial chaos. Nowak then shows how evolutionary dynamics applies to critical real-world problems, including the progression of viral diseases such as AIDS, the virulence of infectious agents, the unpredictable mutations that lead to cancer, the evolution of altruism, and even the evolution of human language. His book makes a clear and compelling case for understanding every living system—and everything that arises as a consequence of living systems—in terms of evolutionary dynamics.

"... introduces a remarkable new approach to trigonometry and Euclidean geometry, with dramatic implications for mathematics teaching, industrial applications and the direction of mathematical research in geometry" -- p. vii.

This volume is a welcome resource for teachers seeking an undergraduate text on advanced trigonometry. Ideal for self-study, this book offers a variety of topics with problems and answers. 1930 edition. Includes 79 figures.

An interdisciplinary history of trigonometry from the mid-sixteenth century to the early twentieth The Doctrine of Triangles offers an interdisciplinary history of trigonometry that spans four centuries, starting in 1550 and concluding in the 1900s. Glen Van Brummelen tells the story of trigonometry as it evolved from an instrument for understanding the heavens to a practical tool, used in fields such as surveying and navigation. In Europe, China, and America, trigonometry aided and was itself transformed by concurrent mathematical revolutions, as well as the

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rise of science and technology. Following its uses in mid-sixteenth-century Europe as the "foot of the ladder to the stars" and the mathematical helpmate of astronomy, trigonometry became a ubiquitous tool for modeling various phenomena, including animal populations and sound waves. In the late sixteenth century, trigonometry increasingly entered the physical world through the practical disciplines, and its societal reach expanded with the invention of logarithms. Calculus shifted mathematical reasoning from geometric to algebraic patterns of thought, and trigonometry's participation in this new mathematical analysis grew, encouraging such innovations as complex numbers and non-Euclidean geometry. Meanwhile in China, trigonometry was evolving rapidly too, sometimes merging with indigenous forms of knowledge, and with Western discoveries. In the nineteenth century, trigonometry became even more integral to science and industry as a fundamental part of the science and engineering toolbox, and a staple subject in high school classrooms. A masterful combination of scholarly rigor and compelling narrative, *The Doctrine of Triangles* brings trigonometry's rich historical past full circle into the modern era.

An invaluable resource for working programmers, as well as a fount of useful algorithmic tools for computer scientists, astronomers, and other calendar enthusiasts, *The Ultimate Edition* updates and expands the previous edition to achieve more accurate results and present new calendar variants. The book now includes coverage of Unix dates, Italian time, the Akan, Icelandic, Saudi Arabian Umm al-Qura, and Babylonian calendars. There are also expanded treatments of the observational Islamic and Hebrew calendars and brief discussions of the Samaritan and Nepalese calendars. Several of the astronomical functions have been rewritten to produce more accurate results and to include calculations of moonrise and moonset. The authors frame the calendars of the world in a completely algorithmic form, allowing easy conversion among these calendars and the determination of secular and religious holidays. LISP code for all the algorithms is available in machine-readable form.

A Publishers Weekly best book of 1995! Dr. Michael Guillen, known to millions as the science editor of ABC's *Good Morning America*, tells the fascinating stories behind five mathematical equations. As a regular contributor to daytime's most popular morning news show and an instructor at Harvard University, Dr. Michael Guillen has earned the respect of millions as a clear and entertaining guide to the exhilarating world of science and mathematics. Now Dr. Guillen unravels the equations that have led to the inventions and events that characterize the modern world, one of which -- Albert Einstein's famous energy equation, $E=mc^2$ -- enabled the creation of the nuclear bomb. Also revealed are the mathematical foundations for the moon landing, airplane travel, the electric generator -- and even life itself. Praised by Publishers Weekly as "a wholly accessible, beautifully written exploration of the potent mathematical imagination," and named a Best Nonfiction Book of 1995, the stories behind *The Five Equations That Changed the World*, as told by Dr. Guillen, are not only chronicles of science, but also

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gripping dramas of jealousy, fame, war, and discovery.

"Witty, compelling, and just plain fun to read . . ." —Evelyn Lamb, *Scientific American* The Freakonomics of math—a math-world superstar unveils the hidden beauty and logic of the world and puts its power in our hands The math we learn in school can seem like a dull set of rules, laid down by the ancients and not to be questioned. In *How Not to Be Wrong*, Jordan Ellenberg shows us how terribly limiting this view is: Math isn't confined to abstract incidents that never occur in real life, but rather touches everything we do—the whole world is shot through with it. Math allows us to see the hidden structures underneath the messy and chaotic surface of our world. It's a science of not being wrong, hammered out by centuries of hard work and argument. Armed with the tools of mathematics, we can see through to the true meaning of information we take for granted: How early should you get to the airport? What does "public opinion" really represent? Why do tall parents have shorter children? Who really won Florida in 2000? And how likely are you, really, to develop cancer? *How Not to Be Wrong* presents the surprising revelations behind all of these questions and many more, using the mathematician's method of analyzing life and exposing the hard-won insights of the academic community to the layman—minus the jargon. Ellenberg chases mathematical threads through a vast range of time and space, from the everyday to the cosmic, encountering, among other things, baseball, Reaganomics, daring lottery schemes, Voltaire, the replicability crisis in psychology, Italian Renaissance painting, artificial languages, the development of non-Euclidean geometry, the coming obesity apocalypse, Antonin Scalia's views on crime and punishment, the psychology of slime molds, what Facebook can and can't figure out about you, and the existence of God. Ellenberg pulls from history as well as from the latest theoretical developments to provide those not trained in math with the knowledge they need. Math, as Ellenberg says, is "an atomic-powered prosthesis that you attach to your common sense, vastly multiplying its reach and strength." With the tools of mathematics in hand, you can understand the world in a deeper, more meaningful way. *How Not to Be Wrong* will show you how.

In a sense, trigonometry sits at the center of high school mathematics. It originates in the study of geometry when we investigate the ratios of sides in similar right triangles, or when we look at the relationship between a chord of a circle and its arc. It leads to a much deeper study of periodic functions, and of the so-called transcendental functions, which cannot be described using finite algebraic processes. It also has many applications to physics, astronomy, and other branches of science. It is a very old subject. Many of the geometric results that we now state in trigonometric terms were given a purely geometric exposition by Euclid. Ptolemy, an early astronomer, began to go beyond Euclid, using the geometry of the time to construct what we now call tables of values of trigonometric functions. Trigonometry is an important introduction to calculus, where one studies what mathematicians call analytic properties of functions. One of the goals of this book is to prepare you for a course in calculus by directing your attention away from particular values of a function to a study of the function as an object in itself. This way of thinking is useful not just in calculus, but in many mathematical situations. So trigonometry is a part of pre-calculus, and is related to other pre-calculus topics, such as exponential and logarithmic functions, and complex numbers.

"Geometry Of Conics deals with the properties of conics (plane curves of second degree) that can be formulated and proved using only elementary geometry. Starting with the well-known optical properties of conics, this book moves to less trivial results, both classical and contemporary. It demonstrates the advantage of purely geometric methods of studying conics."--Publisher's website.

Edited by Time Astronomy, and Calendars in the Jewish Tradition Edited by, edited by Sacha Stern and Charles Burnett, presents a wide selection of original research in the multi-disciplinary field of astronomy and calendars, from Antiquity to the late Middle Ages.

A fun and lively look at the mathematical ideas concealed in video games Did you know that

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every time you pick up the controller to your PlayStation or Xbox, you are entering a world steeped in mathematics? Matthew Lane reveals the hidden mathematics in many of today's most popular video games—and explains why mathematical learning doesn't just happen in the classroom. He discusses how gamers are engaging with the traveling salesman problem when they play Assassin's Creed, why it is mathematically impossible for Mario to jump through the Mushroom Kingdom in Super Mario Bros., how The Sims teaches us the mathematical costs of relationships, and more. Power-Up shows how the world of video games is an unexpectedly rich medium for learning about the mathematical ideas that touch our lives—including our virtual ones.

This new revision of a standard work gives a general but comprehensive introduction to positional astronomy. Useful for researchers as well as undergraduates.

Born of the desire to understand the workings of motions of the heavenly bodies, trigonometry gave the ancient Greeks the ability to predict their futures. Most of what we see of the subject in school comes from these heavenly origins; 15th century astronomer Regiomontanus called it "the foot of the ladder to the stars". In this Very Short Introduction Glen Van Brummelen shows how trigonometry connects mathematics to science, and has today become an indispensable tool in predicting cyclic patterns like animal populations and ocean tides. Its historical journey through major cultures such as medieval India and the Islamic World has taken it through disciplines such as geography and even religious practice. Trigonometry has also been a major player in the most startling mathematical developments of the modern world. Its interactions with the concept of infinity led to Taylor and Fourier series, some of the most practical tools of modern science. The birth of complex numbers led to a shocking union of exponential and trigonometric functions, creating the most beautiful formulas and powerful modelling tools in science. Finally, as Van Brummelen shows, trigonometry allows us to explore the strange new worlds of non-Euclidean geometries, opening up bizarre possibilities for the shape of space itself. And indeed, one of those new geometries - spherical - takes us full circle back to ancient Greek astronomers and European navigators, who first used it to chart their ways across the heavens and the earth. ABOUT THE SERIES: The Very Short Introductions series from Oxford University Press contains hundreds of titles in almost every subject area. These pocket-sized books are the perfect way to get ahead in a new subject quickly. Our expert authors combine facts, analysis, perspective, new ideas, and enthusiasm to make interesting and challenging topics highly readable.

A plain-English guide to the basics of trig Trigonometry deals with the relationship between the sides and angles of triangles... mostly right triangles. In practical use, trigonometry is a friend to astronomers who use triangulation to measure the distance between stars. Trig also has applications in fields as broad as financial analysis, music theory, biology, medical imaging, cryptology, game development, and seismology. From sines and cosines to logarithms, conic sections, and polynomials, this friendly guide takes the torture out of trigonometry, explaining basic concepts in plain English and offering lots of easy-to-grasp example problems. It also explains the "why" of trigonometry, using real-world examples that illustrate the value of trigonometry in a variety of careers. Tracks to a typical Trigonometry course at the high school or college level Packed with example trig problems From the author of Trigonometry Workbook For Dummies Trigonometry For Dummies is for any student who needs an introduction to, or better understanding of, high-school to college-level trigonometry.

What do Bach's compositions, Rubik's Cube, the way we choose our mates, and the physics of subatomic particles have in common? All are governed by the laws of symmetry, which elegantly unify scientific and artistic principles. Yet the mathematical language of symmetry-known as group theory-did not emerge from the study of

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symmetry at all, but from an equation that couldn't be solved. For thousands of years mathematicians solved progressively more difficult algebraic equations, until they encountered the quintic equation, which resisted solution for three centuries. Working independently, two great prodigies ultimately proved that the quintic cannot be solved by a simple formula. These geniuses, a Norwegian named Niels Henrik Abel and a romantic Frenchman named Évariste Galois, both died tragically young. Their incredible labor, however, produced the origins of group theory. The first extensive, popular account of the mathematics of symmetry and order, *The Equation That Couldn't Be Solved* is told not through abstract formulas but in a beautifully written and dramatic account of the lives and work of some of the greatest and most intriguing mathematicians in history.

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The author presents a selection of pieces from his *Scientific American* "Mathematical Games" column, presenting puzzles and concepts that range from arithmetic and geometrical games to the meaning of M.C. Escher's artwork.

Invisible in the Storm is the first book to recount the history, personalities, and ideas behind one of the greatest scientific successes of modern times--the use of mathematics in weather prediction. Although humans have tried to forecast weather for millennia, mathematical principles were used in meteorology only after the turn of the twentieth century. From the first proposal for using mathematics to predict weather, to the supercomputers that now process meteorological information gathered from satellites and weather stations, Ian Roulstone and John Norbury narrate the groundbreaking evolution of modern forecasting. The authors begin with Vilhelm Bjerknes, a Norwegian physicist and meteorologist who in 1904 came up with a method

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now known as numerical weather prediction. Although his proposed calculations could not be implemented without computers, his early attempts, along with those of Lewis Fry Richardson, marked a turning point in atmospheric science. Roulstone and Norbury describe the discovery of chaos theory's butterfly effect, in which tiny variations in initial conditions produce large variations in the long-term behavior of a system--dashing the hopes of perfect predictability for weather patterns. They explore how weather forecasters today formulate their ideas through state-of-the-art mathematics, taking into account limitations to predictability. Millions of variables--known, unknown, and approximate--as well as billions of calculations, are involved in every forecast, producing informative and fascinating modern computer simulations of the Earth system. Accessible and timely, *Invisible in the Storm* explains the crucial role of mathematics in understanding the ever-changing weather. Some images inside the book are unavailable due to digital copyright restrictions.

Many of the earliest books, particularly those dating back to the 1900s and before, are now extremely scarce and increasingly expensive. Pomona Press are republishing these classic works in affordable, high quality, modern editions, using the original text and artwork.

The contents of this book are based on experience gained whilst teaching the subject in the Department of Maritime Studies in the University of Wales Institute of Science and Technology. It is my hope, therefore, that this book will commend itself to teachers of navigational subjects at all levels and particularly to students.

#1 NEW YORK TIMES BESTSELLER • ONE OF TIME MAGAZINE'S 100 BEST YA BOOKS OF ALL TIME The extraordinary, beloved novel about the ability of books to feed the soul even in the darkest of times. When Death has a story to tell, you listen. It is 1939. Nazi Germany. The country is holding its breath. Death has never been busier, and will become busier still. Liesel Meminger is a foster girl living outside of Munich, who scratches out a meager existence for herself by stealing when she encounters something she can't resist—books. With the help of her accordion-playing foster father, she learns to read and shares her stolen books with her neighbors during bombing raids as well as with the Jewish man hidden in her basement. In superbly crafted writing that burns with intensity, award-winning author Markus Zusak, author of *I Am the Messenger*, has given us one of the most enduring stories of our time. “The kind of book that can be life-changing.” —*The New York Times* “Deserves a place on the same shelf with *The Diary of a Young Girl* by Anne Frank.” —*USA Today* **DON'T MISS BRIDGE OF CLAY, MARKUS ZUSAK'S FIRST NOVEL SINCE THE BOOK THIEF.**

The Mathematics of the Heavens and the Earth is the first major history in English of the origins and early development of trigonometry. Glen Van Brummelen identifies the earliest known trigonometric precursors in ancient Egypt, Babylon, and Greece, and he examines the revolutionary discoveries of Hipparchus, the Greek astronomer believed to have been the first to make systematic use of trigonometry in the second century BC while studying the motions of the stars. The book traces trigonometry's development into a full-fledged mathematical discipline in India and Islam; explores its applications to such areas as geography and seafaring navigation in the European Middle Ages and Renaissance; and shows how trigonometry retained its ancient roots at the same time that it became an important part of the foundation of modern mathematics. *The Mathematics of the Heavens and the Earth* looks at the controversies as well, including

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disputes over whether Hipparchus was indeed the father of trigonometry, whether Indian trigonometry is original or derived from the Greeks, and the extent to which Western science is indebted to Islamic trigonometry and astronomy. The book also features extended excerpts of translations of original texts, and detailed yet accessible explanations of the mathematics in them. No other book on trigonometry offers the historical breadth, analytical depth, and coverage of non-Western mathematics that readers will find in *The Mathematics of the Heavens and the Earth*.

Beyond Vision is the first English-language collection of essays on art by Pavel Florensky (1882–1937), Russian philosopher, priest, linguist, scientist, mathematician – and art historian. In addition to seven essays by Florensky, the book includes a biographical introduction and an examination of Florensky's contribution as an art historian by Nicoletta Misler. *Beyond Vision* reveals Florensky's fundamental attitudes to the vital questions of construction, composition, chronology, function and destination in the fields of painting, sculpture and design. His reputation as a theologian and philosopher is already established in the English-speaking world, but this first collection in English of his art essays (translated by Wendy Salmond) will be a revelation to those in the field. Pavel Florensky was a true polymath: trained in mathematics and philosophy at Moscow University, he rejected a scholarship in advanced mathematics in order to study theology at the Moscow Theological Academy. He was also an expert linguist, scientist and art historian. A victim of the Soviet government's animosity towards religion, he was condemned to a Siberian labor camp in 1933 where he continued his work under increasingly difficult circumstances. He was executed in 1937.

How the father of wind engineering helped make the world's most amazing buildings and bridges possible *With Wind Wizard*, Siobhan Roberts brings us the story of Alan Davenport (1932-2009), the father of modern wind engineering, who investigated how wind navigates the obstacle course of the earth's natural and built environments—and how, when not properly heeded, wind causes buildings and bridges to teeter unduly, sway with abandon, and even collapse. In 1964, Davenport received a confidential telephone call from two engineers requesting tests on a pair of towers that promised to be the tallest in the world. His resulting wind studies on New York's World Trade Center advanced the art and science of wind engineering with one pioneering innovation after another. Establishing the first dedicated "boundary layer" wind tunnel laboratory for civil engineering structures, Davenport enabled the study of the atmospheric region from the earth's surface to three thousand feet, where the air churns with turbulent eddies, the average wind speed increasing with height. The boundary layer wind tunnel mimics these windy marbled striations in order to test models of buildings and bridges that inevitably face the wind when built. Over the years, Davenport's revolutionary lab investigated and improved the wind-worthiness of the world's greatest structures, including the Sears Tower, the John Hancock Tower, Shanghai's World Financial Center, the CN Tower, the iconic Golden Gate Bridge, the Bronx-Whitestone Bridge, the Sunshine Skyway, and the proposed crossing for the Strait of Messina, linking Sicily with mainland Italy. Chronicling Davenport's innovations by analyzing select projects, this popular-science book gives an illuminating behind-the-scenes view into the practice of wind engineering, and insight into Davenport's steadfast belief that there is neither a structure too tall nor too long, as long as it is supported by sound wind science. Some images inside the book are unavailable due to digital copyright restrictions.

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"Spherical trigonometry was at the heart of astronomy and ocean-going navigation for two millennia. The discipline was a mainstay of mathematics education for centuries, and it was a standard subject in high schools until the 1950s. Today, however, it is rarely taught. Heavenly Mathematics traces the rich history of this forgotten art, revealing how the cultures of classical Greece, medieval Islam, and the modern West used spherical trigonometry to chart the heavens and the Earth."--Jacket.

Spherical Geometry and Its Applications introduces spherical geometry and its practical applications in a mathematically rigorous form. The text can serve as a course in spherical geometry for mathematics majors. Readers from various academic backgrounds can comprehend various approaches to the subject. The book introduces an axiomatic system for spherical geometry and uses it to prove the main theorems of the subject. It also provides an alternate approach using quaternions. The author illustrates how a traditional axiomatic system for plane geometry can be modified to produce a different geometric world – but a geometric world that is no less real than the geometric world of the plane. Features: A well-rounded introduction to spherical geometry Provides several proofs of some theorems to appeal to larger audiences Presents principal applications: the study of the surface of the earth, the study of stars and planets in the sky, the study of three- and four-dimensional polyhedra, mappings of the sphere, and crystallography Many problems are based on propositions from the ancient text Sphaerica of Menelaus

Plain-language explanations and a rich set of supporting material help students understand the mathematical concepts and techniques of astronomy.

Highlighted by two hundred full-color photographs, a celebration of American crafts and decorative arts and the artists who create them showcases masterpieces of furniture, wood, ceramics, glass, fiber, jewelry, metal, and basketry from the past two centuries, along with a look at how craft has shaped American history, arts, vitality, and identity. 25,000 first printing. The History and Practice of Ancient Astronomy combines new scholarship with hands-on science to bring readers into direct contact with the work of ancient astronomers. While tracing ideas from ancient Babylon to sixteenth-century Europe, the book places its greatest emphasis on the Greek period, when astronomers developed the geometric and philosophical ideas that have determined the subsequent character of Western astronomy. The author approaches this history through the concrete details of ancient astronomical practice. Carefully organized and generously illustrated, the book can teach readers how to do real astronomy using the methods of ancient astronomers. For example, readers will learn to predict the next retrograde motion of Jupiter using either the arithmetical methods of the Babylonians or the geometric methods of Ptolemy. They will learn how to use an astrolabe and how to design sundials using

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Greek and Roman techniques. The book also contains supplementary exercises and patterns for making some working astronomical instruments, including an astrolabe and an equatorium. More than a presentation of astronomical methods, the book provides a critical look at the evidence used to reconstruct ancient astronomy. It includes extensive excerpts from ancient texts, meticulous documentation, and lively discussions of the role of astronomy in the various cultures. Accessible to a wide audience, this book will appeal to anyone interested in how our understanding of our place in the universe has changed and developed, from ancient times through the Renaissance.

In the wrong hands, math can be deadly. Even the simplest numbers can become powerful forces when manipulated by politicians or the media, but in the case of the law, your liberty -- and your life -- can depend on the right calculation. In *Math on Trial*, mathematicians Leila Schneps and Coralie Colmez describe ten trials spanning from the nineteenth century to today, in which mathematical arguments were used -- and disastrously misused -- as evidence. They tell the stories of Sally Clark, who was accused of murdering her children by a doctor with a faulty sense of calculation; of nineteenth-century tycoon Hetty Green, whose dispute over her aunt's will became a signal case in the forensic use of mathematics; and of the case of Amanda Knox, in which a judge's misunderstanding of probability led him to discount critical evidence -- which might have kept her in jail. Offering a fresh angle on cases from the nineteenth-century Dreyfus affair to the murder trial of Dutch nurse Lucia de Berk, Schneps and Colmez show how the improper application of mathematical concepts can mean the difference between walking free and life in prison. A colorful narrative of mathematical abuse, *Math on Trial* blends courtroom drama, history, and math to show that legal expertise isn't always enough to prove a person innocent.

How to predict and calculate the positions of stars, planets, the sun, the moon, and satellites using a personal computer and high school mathematics. Our knowledge of the universe is expanding rapidly, as space probes launched decades ago begin to send information back to earth. There has never been a better time to learn about how planets, stars, and satellites move through the heavens. This book is for amateur astronomers who want to move beyond pictures of constellations in star guides and solve the mysteries of a starry night. It is a book for readers who have wondered, for example, where Saturn will appear in the night sky, when the sun will rise and set, or how long the space station will be over their location. In *Celestial Calculations*, J. L. Lawrence shows readers how to find the answers to these and other astronomy questions with only a personal computer and high school math. Using an easy-to-follow step-by-step approach, Lawrence explains what calculations are required, why they are needed, and how they all fit together. Lawrence begins with basic principles: unit of measure conversions, time conversions, and coordinate systems. He combines these concepts into a computer program that can calculate the location of a star, and uses the same methods for predicting the locations of the sun, moon, and planets. He then shows how to use these methods for locating the many satellites we have sent into orbit. Finally, he describes a variety of resources and tools available to the amateur astronomer, including star charts and astronomical tables. Diagrams illustrate the major concepts, and computer programs that implement the algorithms are included. Photographs of actual celestial objects accompany the text, and interesting astronomical facts are interspersed throughout. Source code (in Python 3, JAVA, and Visual Basic) and executables for all the programs and examples presented in the book are available for download at <https://CelestialCalculations.github.io>.

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