Thiele: Pioneer in Statistics
Steffen L. Lauritzen

Thorvald Nicolai Thiele was a brilliant Danish researcher of the 19th century. He was a professor of Astronomy at the University of Copenhagen and the founder of Hafnia, the first Danish private insurance company. Thiele worked in astronomy, mathematics, actuarial science, and statistics, his most spectacular contributions were in the latter two areas, where his published work was far ahead of his time. This book is concerned with his statistical work. It evolves around his three main statistical masterpieces, which are now translated into English for the first time: 1) his article from 1880 where he derives the Kalman filter; 2) his book from 1889, where he lays out the subject of statistics in a highly original way, derives the half-invariants (today known as cumulants), the notion of likelihood in the case of binomial experiments, the canonical form of the linear normal model, and develops model criticism via analysis of residuals; and 3) an article from 1899 where he completes the theory of the half-invariants. This book also contains three chapters, written by A. Hald and S. L. Lauritzen, which describe Thiele's statistical work in modern terms and puts it into an historical perspective.

The Greate Invention of Algebra
Jacqueline A. Stedall

This book casts new light on the work of Thomas Harriot (c.1560-1621), an innovative thinker and practitioner in several branches of the mathematical sciences, including navigation, astronomy, optics, geometry, and algebra. On his death Harriot left behind over 4,000 manuscript sheets, but most of his work still remains unpublished. This
book focuses on 140 of those sheets, those concerned with the structure and solution of equations. The original material has been carefully ordered, translated, and annotated to provide the first complete edition of Harriot's treatise, and an extended introduction provides the reader with a lucid background to the work. Illustrations from the manuscripts provide additional interest. The appendices discuss correlations between Harriot's manuscripts and those of this contemporaries, Viète, Warner, and Torporley.

Absolute space?
Louis A. Girifalco

in The Universal Force: Gravity - Creator of Worlds
Published in print: 2007 Published Online: January 2008
Publisher: Oxford University Press DOI: 10.1093/acprof:oso/9780199228966.003.0020

Radio astronomy, as first applied by Penzias and Wilson, showed that all space is permeated by a low level of radiation. This is left over from the big bang at the beginning of the universe and is a major factor in proving the validity of Big Bang theory. The existence of the cosmic background radiation, which is everywhere the same, raises the question of the possibility of using it to define an absolute space, and therefore negating relativity theory. It turns out that relativity is still valid because it deals with the relations between observable objects, and is correct regardless of the existence of a background radiation.

What Does a Black Hole Look Like?
Charles D. Bailyn

Published in print: 2014 Published Online: October 2017
Publisher: Princeton University Press DOI: 10.23943/princeton/9780691148823.001.0001

Emitting no radiation or any other kind of information, black holes mark the edge of the universe—both physically and in our scientific understanding. Yet astronomers have found clear evidence for the existence of black holes, employing the same tools and techniques used to explore other celestial objects. This book goes behind the theory and physics of black holes to describe how astronomers are observing these enigmatic objects and developing a remarkably detailed picture of what they look like and how they interact with their surroundings. Accessible to undergraduates and others with some knowledge of introductory college-level physics, this book presents the techniques used to identify...
and measure the mass and spin of celestial black holes. These key measurements demonstrate the existence of two kinds of black holes, those with masses a few times that of a typical star, and those with masses comparable to whole galaxies—supermassive black holes. The book provides a detailed account of the nature, formation, and growth of both kinds of black holes. The book also describes the possibility of observing theoretically predicted phenomena such as gravitational waves, wormholes, and Hawking radiation. A cutting-edge introduction to a subject that was once on the border between physics and science fiction, this book shows how black holes are becoming routine objects of empirical scientific study.

Statistics, Data Mining, and Machine Learning in Astronomy
Željko Ivezic, Andrew J. Connolly, Jacob T VanderPlas, and Alexander Gray

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Item type: book

As telescopes, detectors, and computers grow ever more powerful, the volume of data at the disposal of astronomers and astrophysicists will enter the petabyte domain, providing accurate measurements for billions of celestial objects. This book provides a comprehensive and accessible introduction to the cutting-edge statistical methods needed to efficiently analyze complex data sets from astronomical surveys such as the Panoramic Survey Telescope and Rapid Response System, the Dark Energy Survey, and the upcoming Large Synoptic Survey Telescope. It serves as a practical handbook for graduate students and advanced undergraduates in physics and astronomy, and as an indispensable reference for researchers. The book presents a wealth of practical analysis problems, evaluates techniques for solving them, and explains how to use various approaches for different types and sizes of data sets. For all applications described in the book, Python code and example data sets are provided. The supporting data sets have been carefully selected from contemporary astronomical surveys (for example, the Sloan Digital Sky Survey) and are easy to download and use. The accompanying Python code is publicly available, well documented, and follows uniform coding standards. Together, the data sets and code enable readers to reproduce all the figures and examples, evaluate the methods, and adapt them to their own fields of interest.
Progress in modern radio astronomy led to the discovery of space masers in the microwave range, and it became a powerful tool for studies of interstellar star-forming molecular clouds. Progress in observational astronomy, particularly with ground-based huge telescopes and the space-based Hubble Space Telescope, has led to recent discoveries of space lasers in the optical range. These operate in gas condensations in the vicinity of the mysterious star Eta Carinae (one of the most luminous and massive stars of our Galaxy). Both maser and laser effects, first demonstrated under laboratory conditions, have now been discovered to occur under natural conditions in space too. This book describes consistently the elements of laser science, astrophysical plasmas, modern astronomical observation techniques, and the fundamentals and properties of astrophysical lasers.

Ptolemy's Philosophy
Jacqueline Feke

The Greco-Roman mathematician Claudius Ptolemy is one of the most significant figures in the history of science. He is remembered today for his astronomy, but his philosophy is almost entirely lost to history. This book reconstructs Ptolemy's general philosophical system—including his metaphysics, epistemology, and ethics—and to explore its relationship to astronomy, harmonics, element theory, astrology, cosmology, psychology, and theology. The book uncovers references to a complex and sophisticated philosophical agenda scattered among Ptolemy's technical studies in the physical and mathematical sciences. It shows how he developed a philosophy that was radical and even subversive, appropriating ideas and turning them against the very philosophers from whom he drew influence. The book reveals how Ptolemy's unique system is at once a critique of prevailing philosophical trends and a conception of the world in which mathematics reigns supreme. The book demonstrates how Ptolemy situated mathematics at the very foundation of all philosophy—theoretical and practical—and advanced the mathematical way of life as the true path to human perfection.
Historical Supernovae and their Remnants
F. Richard Stephenson and David A. Green

This book reviews both the historical observations of supernovae (SNe) seen in our Galaxy over the last two millennia — and recorded in East Asia (China, Japan, Korea) as ‘guest stars’, Europe and the Arab dominions — together with modern observations of the remnants of these supernovae. Introductory chapters provide background information on the historical observations and our modern understanding of supernovae and novae, and of supernova remnants (SNRs) and pulsars. One chapter discusses the young SNR Cassiopeia A, and the proposed sighting of its SN in AD 1680 by Flamsteed. Subsequent chapters discuss the historical observations of the well-defined historical SNe and modern observations of their remnants. These chapters cover Kepler's SN of AD 1604, Tycho's SN of AD 1572, the SN of AD 1181, the SN of AD 1054 that produced the well-known Crab Nebula; and the especially bright SN of AD 1006. Earlier probable and possible supernovae of the preceding millennium chronicled in China are also discussed, along with their possible remnants. Other less certain observations of SNe, and the future potential for additional historical observations, are briefly discussed. This book also includes, as an appendix, a catalogue of over two hundred known Galactic SNRs.

From Cosmos to Chaos
Peter Coles

Cosmology has undergone a revolution in recent years. The exciting interplay between astronomy and fundamental physics has led to dramatic revelations, including the existence of the dark matter and the dark energy that appear to dominate our cosmos. However, these discoveries only reveal themselves through small effects in noisy experimental data. Dealing with such observations requires the careful application of probability and statistics. But it is not only in the arcane world of fundamental physics that probability theory plays such an important role. It has an impact in many aspects of our everyday life, from the law courts to the lottery. Why then do so few people understand probability? And why do so few people understand why it is so important
for science? Why do so many people think that science is about absolute certainty when, at its core, it is actually dominated by uncertainty? This book attempts to explain the basics of probability theory, and illustrate their application across the entire spectrum of science.

Stellar-Mass Black Holes
Charles D. Bailyn

in What Does a Black Hole Look Like?
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Item type: chapter

This chapter examines stellar-mass black holes. The empirical study of black holes began in the 1960s with the discovery of quasars and the advent of X-ray astronomy. X-ray detectors could detect X-rays coming from a particular direction—as the instrument rotated, the detector scanned the sky. It was not expected that X-ray sources from outside the solar system would be detectable. However, it was quickly discovered that there were strong X-ray sources that appeared in the same position in every scan. The inferred luminosity of the sources was hundreds or thousands of times brighter than the Sun. When coincident optical stars were identified, they proved to be relatively faint. Thus, it was clear that a new class of celestial sources must exist whose radiation is predominantly in the form of X-rays, with a total luminosity comparable to or greater than that of ordinary stars.

Coda
Michael Ward

in Planet Narnia: The Seven Heavens in the Imagination of C. S. Lewis
Published in print: 2008 Published Online: January 2008
Publisher: Oxford University Press DOI: 10.1093/acprof:oso/9780195313871.003.0012
Item type: chapter

Reasons why Lewis's critics were not looking for a secret layer of meaning. Reasons why Lewis's critics were not interested in astrology. The extent to which Lewis knew about astronomy. The extent to which he believed in astrology. The circumstances in which the donegalitarian discovery was made.
A shift in how we understand reality.

Table making in astronomy
Arthur L. Norberg

Throughout history, astronomers have studied the motions of the bodies of the solar system. In the second half of the 17th century, these studies took a monumental step forward with Isaac Newton's (1642–1727) formulation of the laws of motion and the principle of universal gravitation. The development of analytical mechanics in the 18th century opened the way for a complete treatment of all the gravitational effects produced within the solar system, as required to predict the motions of these bodies. Gravitational astronomers, who formulated equations of motion for the interactions of the planets, discovered that these equations could not be integrated in closed form, and developed approximation techniques for the successful integration of the equations. The history of predicting planetary positions using theories developed in celestial mechanics involved a search for a complete unified set of precepts for use in computing future planetary positions. This search was occasionally beset by related difficulties due to inadequacies in astronomers' planetary observations and understanding of planetary interactions. Therefore, it took almost 200 years after Newton to realize the goal. The drama has a cast of epic proportions and its denouement occurred at the beginning of the 20th century in Paris with a major assembly of astronomers at an international conference. This chapter examines some highlights in this history, namely, the search, the problem of seemingly unstabilizing interactions, and the difficulties with observation, focusing on only a few of the principal actors and institutions. Primary emphasis in the chapter is on the first stage in the process of predicting future planetary positions, namely, preparation.
of precepts, rather than the following stage of computing predicted positions.

Ovid's Fasti
Geraldine Herbert-Brown (ed.)

This book celebrates the bimillennial anniversary of the inception of Ovid’s Fasti by offering a variety of approaches to Ovid’s poem on the Roman religious calendar. The volume does not aim at consensus but provides a collection of differing interpretations and perspectives of Fasti scholars without allowing any single prejudice to prevail. In reconstructing the value-systems which inform the poem, twelve contributors discuss topics such as the calendar, religion, politics, women, mime, myth, theatre, cult, astronomy, astrology, theology, intertextuality, gender, poetic ecphrasis, speech, time, and space. The tension arising from the discrepancy in interpretation and approach in the essays is an apt reflection of the tension arising from the contradictory and elusive nature of the Fasti itself. It will engage all those interested in the relationship between literature and society during the early Roman Principate.

Astronomy
Leonid Zhmud

This chapter begins with a discussion of Egyptian and Babylonian influences in Greek astronomy. It considers the development of Pythagorean astronomy before Philolaus. It then focuses on the difficulty of identifying an individual contribution to astronomy by Pythagoras or specific early Pythagoreans. It shows that Alexander relied on Aristotle, who connected with Philolaus neither the harmony of the spheres nor the geocentric model on which it is based. The surviving works of Aristotle actually contain no indication that he associated the harmony of the spheres with Philolaus' system.
Isaac Newton’s Chronology of Ancient Kingdoms Amended, published in 1728, one year after the great man’s death, unleashed a storm of controversy. And for good reason. The book presents a drastically revised timeline for ancient civilizations, contracting Greek history by five hundred years and Egypt’s by a millennium. This book tells the story of how one of the most celebrated figures in the history of mathematics, optics, and mechanics came to apply his unique ways of thinking to problems of history, theology, and mythology, and of how his radical ideas produced an uproar that reverberated in Europe’s learned circles throughout the eighteenth century and beyond. The book reveals the manner in which Newton strove for nearly half a century to rectify universal history by reading ancient texts through the lens of astronomy, and to create a tight theoretical system for interpreting the evolution of civilization on the basis of population dynamics. It was during Newton’s earliest years at Cambridge that he developed the core of his singular method for generating and working with trustworthy knowledge, which he applied to his study of the past with the same rigor he brought to his work in physics and mathematics. Drawing extensively on Newton’s unpublished papers and a host of other primary sources, the book reconciles Isaac Newton the rational scientist with Newton the natural philosopher, alchemist, theologian, and chronologist of ancient history.

Vaga Signa: Orion and Sirius in Ovid's Fasti

Emma Gee

in Ovid's Fasti: Historical Readings at its Bimillennium
context in the Fasti, and on the place of astronomy in the work as a whole.

The Devil in the Detail
Mary Orr

in Flaubert's Tentation: Remapping Nineteenth-Century French Histories of Religion and Science

Devil's rides into space are a well-worked topos in literature, but this chapter points out for the first time their literal realities in the Montgolfier balloons and Garnarin's parachute that constitute the 19th-century 'transports' of Antoine's literary-scientific imagination. The chapter then offers further appraisal of what the Devil 'shows' Antoine in space, namely (1) the (19th-century) heliocentric solar system with the new planets, Uranus and Neptune discovered through understanding of gravitational pull, and (2) the huge literary-scientific joke behind the Devil's transformations as the Norman mathematician Laplace's famous 'demon'. The chapter ends by rethinking the genesis of the Tentation through the modern mystères of Le Poittevin's Bélial and Byron's Cain as among Flaubert's personal demons.

Adam Smith and the Classics
Gloria Vivenza

Adam Smith's thought was indebted to the classical training prevailing in the educational system of his day. A careful reading of all his writings can prove the extent of this debt. Classical influences are obviously more numerous and easily discernible in the philosophical works, but are not absent from the economic masterpiece. They have been described by the author without having recourse to conjectures or implications, rather by analysing the topics whose classical origin can be ascertained. The book has been divided into chapters devoted to the traditional branches of knowledge treated by Adam Smith: natural philosophy, ethics, jurisprudence, economics, literature; plus a postscript. Smith was not only influenced by classical doctrines but he also selected from them arguments.
This chapter traces Arago and Biot's fundamental differences in transparency vs. opacity through their work in astronomy. When Arago was director of the Paris Observatory he spent a great deal of effort debunking what he called superstitious myths of celestial influence. Using his optical instruments, he studied the radiations of comets, the moon and other heavenly bodies, ultimately claiming they could have no appreciable effect on Earth. Biot, on the other hand, working with Champollion, immersed himself in the study of ancient Chinese and Egyptian astronomy. He was particularly engrossed with the zodiacs of both cultures, which he represented as a moment of profound original knowledge hinting at a relation between heavens and earth.