

Universe Stars And Galaxies 4th Edition Freedman

Universe: Stars and Galaxies, Fourth Edition, contains chapters from the following sections of Freedman, Kaufmann and Geller's Universe, Ninth Edition: Introducing Astronomy Stars and Stellar Evolution Galaxies and Cosmology

A Nobel Prize-winning physicist explains what happened at the very beginning of the universe, and how we know, in this popular science classic. Our universe has been growing for nearly 14 billion years. But almost everything about it, from the elements that forged stars, planets, and lifeforms, to the fundamental forces of physics, can be traced back to what happened in just the first three minutes of its life. In this book, Nobel Laureate Steven Weinberg describes in wonderful detail what happened in these first three minutes. It is an exhilarating journey that begins with the Planck Epoch - the earliest period of time in the history of the universe - and goes through Einstein's Theory of Relativity, the Hubble Red Shift, and the detection of the Cosmic Microwave Background. These incredible discoveries all form the foundation for what we now understand as the "standard model" of the origin of the universe. The First Three Minutes examines not only what this model looks like, but also tells the exciting story of the bold thinkers who put it together. Clearly and accessibly written, The First Three Minutes is a modern-day classic, an unsurpassed explanation of where it is we really come from.

Since man first began looking at the stars, he's wondered about their origins and his own. Modern astronomers have explained the beginnings of the universe with the Big Bang Theory, in which all matter erupted from a single explosion billions of years ago. As the universe's mysteries have deepened, astronomers have introduced an increasing number of concepts which defy understanding, such as an expanding and accelerating universe, galaxies at incredible distances, massive and unexplainable black holes, quasars and bazars with unbelievable distances and energy, dark matter and dark energy which supposedly comprise 96% of the universe but can't be found, pulsars which defy logic, and many other phenomenon which stretch our imagination. Amateur astronomer Jerrold Thacker calls the Big Bang Theory and its accompanying scientific theories preposterous. Instead, he proposes an alternate explanation for what we observe, based not on the prevailing Doppler Effect and the concept that the universe's galaxies are receding from our own with increasing velocity but on the "Tired Light" Effect, based on Einstein's General Theory of Relativity, which shows that gravitational fields in outer space slow light, causing a color shift in light produced by distant objects. This new and totally different view of the universe explores the "Tired Light" Effect on what we observe in the universe. The author dismisses much of what is currently espoused by the astronomical community. Instead, he points to Einstein's predictions and their integral role in explaining every phenomenon hypothesized by modern astronomers, revealing the wonder of the cosmos without a big bang or expanding universe.

With 21st Century Astronomy, students see the universe through the eyes of a scientist.

This introduction to astronomy features an exceptionally clear writing style, an emphasis on critical thinking and visualization, and a leading-edge technology program-including an accompanying full-featured electronic multimedia version of the book and companion Web site. A dynamic art program includes numerous radio, infrared, ultraviolet, X-ray, and gamma-ray images and transparent full-color overlays. The book presents scientific literacy in the context of astronomy, with the aim of teaching students to think critically and analytically about the physical world and the development of science. The text requires a minimum level of simple algebra and trigonometry. It presents an explanation of key physical principles and techniques like Kepler and Newton's laws, spectroscopy and distance measurement (the cosmic distance ladder is used throughout).

Using a wealth of high-resolution images collected by a fleet of telescopes, satellites and inter-planetary probes, UNIVERSE embarks on a voyage to the edge of the cosmos. After a fly past of our planetary neighbours we reach the edge of the solar system - a mere 15 light hours away - and emerge into interstellar space and head for the heart of our galaxy. The rhythms of stellar life unfold before our eyes: dark clouds of dust and gas blaze with clusters newly smelted stars, dying stars bloom and fade as planetary nebulae, or tear themselves apart as supernovae. Navigating through thick swarms of stars, we reach the galactic core, a gravitational maelstrom of exotic stars in the thrall of a supermassive black hole. Hundreds of thousands of light years must be covered to reach the Milky Way's companions, the Large and Small Magellanic Clouds, and millions more devoured before we cross true intergalactic space. Out here we watch the hidden lives of galaxies: we see them locked in gravitational combat, tearing each other apart or swallowing their companions whole. Now billions of light years from Earth, we can discern the large-scale structure of the universe: massive conglomerations of galaxies gather like grains of dust on a veil of cobwebs, warping space with their tremendous gravity. Having crossed an almost unimaginable 13.4 billion light years, we encounter a wall of radiation. Here our voyage into the cosmos must finally end, for we have reached the very edge of the visible universe: what stands before us is the afterglow of the Big Bang itself.

Text and color photographs examine the creation of the universe, planets, galaxies, and stars, telescopes, the Big Bang theory, and more.

South Africa - a land of paradigm shifts. A land where we are willing to leave behind the old, to bravely accept the new. What do we need to exit the dark ages in the morphology of galaxies? How prevalent is the cherishing of old concepts? Traditional morphology has been 'mask-oriented', focusing on masks of dust and gas which may constitute only 5 percent of the dynamical mass of a galaxy. Some of the world's foremost astronomers flew to South Africa to address morphologically related issues at an International Conference, the proceedings of which are contained in this volume. Examine predicted extinction curves for primordial dust at high redshift. Stars evolve; why not dust? Read about the breakdown of the Hubble sequence at a redshift of one. Explore the morphology of rings; the mysteries of metal-rich globular clusters; vigorous star-formation in the Large Magellanic Cloud; the world of secular evolution, where galaxies change their shapes within one Hubble time. And much more. Examine a new kinematical classification scheme of the unmasked, dust-penetrated near-infrared images of spiral galaxies. This volume contains over 80 refereed contributions (including 18 in-depth keynote review articles), 40 pages of questions and answers, a panel discussion transcribed from tape and 24 colour plates. The volume is unique in that contributions from both high and low redshift experts are represented at a level readily accessible to postdoctoral students entering the exciting world of morphology - whether it be of the local, or more distant, Universe.

Includes, beginning Sept. 15, 1954 (and on the 15th of each month, Sept.-May) a special section: School library journal, ISSN 0000-0035, (called Junior libraries, 1954-May 1961). Also issued separately.

This book takes the reader on an exploration of the structure and evolution of our universe. The basis for our knowledge is the Big Bang theory of the expanding universe. This book then tells the story of our search for the first stars and galaxies using current and planned

telescopes. These telescopes are marvels of technology far removed from Galileo's first telescope but continuing astronomy in his ground breaking spirit. We show the reader how these first stars and galaxies shaped the universe we see today. This story is one of the great scientific adventures of all time.

Teaches students to think like scientists.

The epic, behind-the-scenes story of an astounding gap in our scientific knowledge of the cosmos. In the past few years, a handful of scientists have been in a race to explain a disturbing aspect of our universe: only 4 percent of it consists of the matter that makes up you, me, our books, and every planet, star, and galaxy. The rest—96 percent of the universe—is completely unknown. Richard Panek tells the dramatic story of how scientists reached this conclusion, and what they're doing to find this "dark" matter and an even more bizarre substance called dark energy. Based on in-depth, on-site reporting and hundreds of interviews—with everyone from Berkeley's feisty Saul Perlmutter and Johns Hopkins's meticulous Adam Riess to the quietly revolutionary Vera Rubin—the book offers an intimate portrait of the bitter rivalries and fruitful collaborations, the eureka moments and blind alleys, that have fueled their search, redefined science, and reinvented the universe. Late in 2016, the scientists, with a little help from the big LHC, the particle accelerator down in Cern, finally concluded that there are no physical particles to be found inside this universe!! Meaning only energetic oscillating fields was to be found! Can you even grasp that thought, that everything in this universe, is absolutely anything but being this postulated 3-dimensionally and fully physical universe, that you thought you could understand, and that you have been educated in? Everything you believed this universe to be, does not exist at all!! You don't find anything inside this universe, that is only 3-dimensional and only fully physical! And everything you did not believe in, is the universe we actually live inside, with only energetic oscillating fields! We live inside a paranormal universe with 5 very active quantum physical dimensions! It is actually these two quantum physical dimensions, the 5th and the 4th, that really runs the show! We can only see, discover and detect this universe inside the 3rd dimension, and that dimension is "the quantum physical screen" of the universe! This is where the Higg's field is operating with the funny universal stuff, a stuff that can be there, disappear and reappear again! That leads us into the stealth technology and the physics behind the famous stealth plane, the new 5-dimensional quantum physics! The only kind of believes, and the only kind of education today, lies inside this 3-dimensional and fully physical standardized big bang model and physics, and all of that is a big lie! That was the final conclusion from the big LHC down in Cern! This very famous and shocking discovery actually proved my new 5-dimensional model, by proving the energetic oscillating quantum physical atom, that lies in a 5-dimensional spacetime. My new 5-dimensional quantum physical model and totally new physics was theoretically fully proven already in 2012! Then the big process writing down all of this new philosophy and theory! Out of that, came the new 5-dimensional quantum physical physics! Very different on any level! This new model matches Einstein's extended relativity theory and can be understood as a Pier Review with Einstein's 5-dimensional model. It explains the gravity, the differentiated expansion, explains the very big inflation, and many more hidden secrets of the universe! Read about the Author, and the book, and understand how this universe was created and how it functions!

"Building on the first edition, this book features 330 high resolution celestial portraits selected by bestselling astronomy writer Terence Dickinson, a four-page fold-out of the Andromeda Galaxy and an illuminating narrative that brings to life Hubble's journey and the fascinating forces at work in the universe."--

"This is a truly astonishing book, invaluable for anyone with an interest in astronomy." Physics Bulletin "Just the thing for a first year university science course." Nature "This is a beautiful book in both concept and execution." Sky & Telescope

Explore the known Universe and consider its mind-boggling scale in this crisply illustrated, well-researched picture book from Caldecott honoree Jason Chin. Winner of the Cook Prize! Most eight-year-olds are about five times as tall as this book . . . but only half as tall as an ostrich, which is half as tall as a giraffe . . . twenty times smaller than a California Redwood! How do they compare to the tallest buildings? To Mt. Everest? To stars, galaxy clusters, and . . . the universe? Jason Chin, the award-winning author and illustrator of Grand Canyon has once again found a way to make a complex subject--size, scale and almost unimaginable distance--accessible and understandable to readers of all ages. Meticulously researched and featuring the highly detailed artwork for which he is renowned, this is How Much is a Million for the new millenium, sure to be an immediate hit with kids looking for an engaging way to delve into perspective, astronomy, and astrophysics. Curious readers will love the extensive supplementary material included in the back of the book An American Library Association Notable Children's Book A New England Book Award Finalist A Kirkus Reviews Best Book of the Year A School Library Journal Best Book of the Year A Junior Library Guild Gold Standard Selection A Horn Book Fanfare Best Book of the Year A Bank Street Best Children's Book of the Year!

Universe. When it comes to staying current with latest discoveries, clearing away common misconceptions, and harnessing the power of media in the service of students and instructors, no other full-length introduction to astronomy can match it. Now the textbook that has evolved discovery by discovery with the science of astronomy and education technology for over two decades returns in spectacular new edition, thoroughly updated and offering unprecedented media options. Available in Split Volumes Universe: Stars and Galaxies, Fourth Edition, 1-4292-4015-6 Universe: The Solar System, Fourth Edition, 1-4292-4016-4

This popular science book offers a glimpse into a plethora of extreme cosmic phenomena in which the theories of modern physics, particularly quantum mechanics and general relativity, play a key role. Despite their vastly different appearances, these cosmic phenomena have much in common: they are all powered by exotic stars -- black holes, neutron stars and white dwarfs -- collectively called compact objects. The book describes, in accessible language, the physics underlying these phenomena, the historical background that led to their discovery, and the various observational techniques used by astronomers for their exposure. The book contains many spectacular photographs taken with modern telescopes around the world and satellites of different space agencies, as well as illustrations specially prepared by the author to enhance the reading experience. Contents: IntroductionFirst Episode: The Universe and All That Is In It: The History of the UniverseThe Genesis of Galaxies and the Birth of Giant Black HolesStellar Evolution -- From Dust Cloud to Black HoleSecond Episode: Physics and Astronomy in the 21st Century: Matter, Force, and Symmetry in NaturePrinciples of Modern AstronomyElectromagnetic Radiation: Kinds and ClassesThe Elusive NeutrinoGravitational Waves: Spacetime VibrationsCosmic Rays -- A Shower of Energetic Particles from the UniverseThird Episode: A Menagerie of Extreme Phenomena: White Dwarfs and the Quantum TheoryNeurton Stars -- The Largest Atomic Nuclei in the UniverseQuark Stars and Strange MatterLighthouses in the UniverseMagnetars -- The Universe's Largest MagnetsBlack Holes -- The Crown Jewel of Einstein's TheoryThe Black Holes' Magic ShowDeath and Birth -- The Tale of Cosmic ExplosionsMighty Bursts from Deep SpaceEpilogue Readership: Non-professional readers interested in science in general, and physics and astronomy in particular. Keywords: Astronomy;Black Holes;Gravitational Waves;Cosmic Rays;Popular ScienceReview:0

This book looks at answers to the biggest questions in astronomy – the questions of how the planets, stars, galaxies and the universe were formed. Over the last decade, a revolution in observational astronomy has produced possible answers to three of these questions. This book describes this revolution. The one question for which we still do not have an answer is the question of the origin of the universe. In the final chapter, the author looks at the connection between science and philosophy and shows how new scientific results have laid the groundwork for the first serious scientific studies of the origin of the universe.

Space Atlas combines updated maps, lavish photographs, and elegant illustrations to chart the solar system, the universe, and beyond. For space enthusiasts, science lovers, and star gazers, here is the newly revised edition of National Geographic's enduring guide to space, with a new introduction by American hero Buzz Aldrin. In this guided tour of our planetary neighborhood, the Milky Way and other galaxies, and

beyond, detailed maps and fascinating imagery from recent space missions partner with clear, authoritative scientific information. Starting with the sun and moving outward into space, acclaimed science writer and physicist James Trefil illuminates each planet, the most important moons, significant asteroids, and other objects in our solar system. Looking beyond, he explains what we know about the Milky Way and other galaxies--and how we know it, with clear explanations of the basics of astrophysics, including dark matter and gravitational waves. For this new edition, and to celebrate the 50th anniversary of his moonwalk, astronaut and American hero Buzz Aldrin offers a new special section on Earth's moon and its essential role in space exploration past and future.

Stacy Palen knows that introductory astronomy may be the only science course some students take in their college careers, so it's their best chance to develop scientific literacy. Education research shows that the best way to attain scientific literacy is through active learning.

Understanding Our Universe, Fourth Edition makes it easier for instructors to help students understand the concepts and learn to value science by providing activities that can be used before, during, and after class. By expanding her pedagogy to include What If scenarios and What an Astronomer Sees figure captions, Stacy helps students build scientific literacy and to think critically about science in the media.

The stars have never seemed closer than they do with the Astronomy Pack. Suitable for use in the Northern Hemisphere, the pack contains four essential items to introduce the beginner to the fascinating hobby of astronomy: a 'glow-in-the-dark' planisphere, an 80-page paperback book about the stars and planets, a colorful moon map, and newly updated star chart. **Glow-in-the-Dark Planisphere:** This planisphere has been specially made so that, after being held under a bright light, the stars and the names and shapes of the constellations will glow in the dark for a period. It is both a fun and practical star finder for identifying the stars and constellations visible on any night of the year from the US and Southern Canada (42 degrees North); the star map is drawn by the well-known celestial cartographer Wil Tirion. A sheet explaining how to use the planisphere is included in the pack. **Exploring Stars and Planets:** A colorful and entertaining introduction to the exciting world of astronomy, this 80-page paperback is illustrated with more than 200 color photographs, artworks and maps, as the author Ian Ridpath describes the latest developments in the fast-moving fields of space exploration and astronomy. Concise chapters introduce the Sun, the Earth and all the other planets in our Solar System. Then, moving further into space, the author examines the stars and galaxies, and explores the origin of the Universe. **Star Chart:** This Star Chart shows the stars and constellations of the night sky in three superb maps: the northern and southern hemispheres, and the equatorial region. All stars visible with the naked eye are shown, with the brightest stars shown in their true colours. Fainter star clusters and nebulae are marked for observers using binoculars or small telescopes. Constellations, double stars and variable stars are also listed, and an informative accompanying text explains how to use the charts throughout the year, at any latitude. In a convenient folded format, Star Chart is suitable for use in both northern and southern latitudes. **Moon Map:** In a convenient folded format, the Moon Map is a superbly detailed, large-format map of the near (visible) side of the Moon. Specially drawn for by Dr John Murray, an expert on the lunar surface, the map is not only a highly accurate and clear representation of the Moon but is also a practical guide for lunar observers. More than 500 physical features - craters, seas, mountain ranges, peaks, valleys and rilles (elongated depressions) - are named and indexed, and the landing sites of unmanned and manned spacecraft are also marked. The observer can thus readily identify objects seen through binoculars or a telescope, or pick targets for a program of observation.;The accompanying text is a practical guide to Moonwatching, which explains how to use the map and highlights the most interesting lunar features. Close-up images of some of these objects show what the observer can expect to see. Also included are photographs of the Moon at each daily stage and a smaller map of the far side, as revealed by satellites. Guidelines on drawing or photographing the Moon are also included.

Your updated guide to exploring the night sky Do you know the difference between a red giant and a white dwarf? From asteroids to black holes, this easy-to-understand guide takes you on a grand tour of the universe. Featuring updated star maps, charts, and an insert with gorgeous full-color photographs, Astronomy For Dummies provides an easy-to-follow introduction to exploring the night sky. Plus, this new edition also comes with chapter quizzes online to help your understanding. For as long as people have been walking the earth, those people have looked up into the night sky and wondered about the nature of the cosmos. Without the benefit of science to provide answers, they relied on myth and superstition to help them make sense of what they saw. Lucky for us, we live at a time when regular folks, equipped with nothing more than their naked eyes, can look up into the night sky and gain admittance to infinite wonders. If you know what to look for, you can make out planets, stars, galaxies, and even galactic clusters comprising hundreds of millions of stars and spanning millions of light-years. Whether you're an amateur astronomer, space enthusiast, or enrolled in a first year astronomy course, Astronomy For Dummies gives you a reason to look into the heavens. Includes updated schedules of coming eclipses of the Sun and Moon and a revised planetary appendix Covers recent discoveries in space, such as water on the Moon and Pluto's demotion from "planet" status Collects new websites, lists of telescope motels, sky-watching guides, and suggestions for beginner's telescopes and suppliers Provides free online access to chapter quizzes to help you understand the content Ever wonder what's out there in the big ol' universe? This is the book for you!

Summarizes the current knowledge and theories in the field of astronomy with regard to the universe, from supernovas and black holes to quasars and the big bang theory

Tailored for students taking an introductory astronomy class, this newest edition (4th) brings students the latest astronomical discoveries in an easy-to-read format by building on cutting-edge teaching and learning research that helps students learn most efficiently. Topics include night sky, formation of planets, evolution of stars and galaxies, and structure of the universe, each with easy-to-understand illustrations. Created with students in mind, this book works equally well for students taking classes assigned either the earlier 2nd or 3rd editions of this internationally published book, but at a much lower cost with updated information.

The 13th Edition of HORIZONS means the proven Seeds/Backman approach and trusted content, fully updated with the latest discoveries and resources to meet the needs of today's diverse students. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version.

Discovering the Universe, Fifth Edition is one of the briefest texts available for an introductory astronomy course, while providing the wide range of factual topics that are the hallmark of the text and are consistent with most course needs. By flipping through the book, readers will find it as rich in celestial images and figures as other textbooks for the same audience. It is a balanced approach to content, depth, and breath, with effective teaching resources. It is also up-to-date, reflecting how our knowledge about the universe is expanding at a phenomenal rate.

From our solar system neighbors to the mysteries of deep space, this remarkable book explores the planets and stars of our galaxy and beyond. Will interplanetary travel become routine? Why do stars explode? KFK Stars & Planets will motivate avid young astronomers and aspiring astronauts to consider all the biggest questions.

This straightforward volume presents a broad view of astronomy spanning known facts, evolving ideas, and frontier discoveries. The authors combine qualitative reasoning and analogies with familiar objects and phenomena to awaken readers to the excitement of the universe around them. Incorporates new understanding and emphases in contemporary astronomy, including the latest data on topics ranging from adaptive optics and solar system formation to extrasolar planets and the recent missions to Mars. Top-notch illustration program exploits the full range of the electromagnetic spectrum, including images taken at radio, infrared, ultraviolet, X-ray, or gamma-ray wavelengths, in addition to visible-light photographs. For anyone interested in learning more about astronomy.

The dawn of the first stars, galaxies and black holes signaled a fundamental milestone in our Universe's evolution: the Epoch of Reionization. The light from these galactic ancestors began spreading out, ionizing virtually every atom in existence. Our Universe

transitioned from darkness to light, from cold to hot, from simple and boring to the wondrous cosmic zoo we see around us today. Despite its importance, observations of reionization have been few, and their interpretation has been highly controversial. Fortunately, this is rapidly changing. We will soon enter the "Big Data" era of this mysterious epoch, driven by an upcoming wave of observations with state-of-the-art telescopes as well as new sophisticated analysis tools. The aim of this volume is to summarize the current status and future outlook of the reionization field. We bring together leading experts in many sub-disciplines, highlighting the measurements that will illuminate our understanding of reionization and the cosmic dawn: (i) 21cm interferometry; (ii) high-redshift quasar spectra; (iii) high-redshift galaxy surveys; (iv) primary and secondary anisotropies of the Cosmic Microwave Background; (v) high-resolution studies of the metal content of early galaxies. We seek a roadmap to interpreting the wealth of upcoming observations. What is the best use of limited observational resources? How do we develop theoretical tools tailored for each observation? Ultimately, what will we learn about the epoch of reionization and our galactic ancestors?

Designed to provide readers with an enriched sense of the astronomical world, this edition continues to explain how astronomers think about the cosmos and describes the full range of the astronomical universe. Retaining the structure of previous editions, it is divided into four coherent parts including: the changing conceptions of the cosmos; the planets, both past and present; the universe of stars; the galaxies and cosmic evolution. Innovations in this edition include: revised artwork, consistent symbolism, a running glossary of selected terms placed within the margins, the use of four-color photography/printing, the inclusion of the latest findings and theories concerning our planet, our galaxy and the universe.

The volume presents a broad coverage of this timely subject. The work is up-to-date and detailed enough to constitute a fine reference for experimental as well as for theoretical physicists, but also maintains an informative pedagogical tone so that it can serve as the basis for a modern course on the subject. Major sections include fundamentals of particle physics with results from accelerator experiments, the particle-cosmology interface, neutrino physics, large scale searches for proton decay and for exotic matter in the universe, neutrino astronomy, the physics of cosmic rays and gamma ray astronomy. A portion of the volume deals with facilities and instrumentation for particle astrophysics and on data acquisition.

If standard gravitational theory is correct, then most of the matter in the universe is in an unidentified form which does not emit enough light to have been detected by current instrumentation. This book is the second edition of the lectures given at the 4th Jerusalem Winter School for Theoretical Physics, with new material added. The lectures are devoted to the "missing matter" problem in the universe, the search to understand dark matter. The goal of this volume is to make current research work on unseen matter accessible to students without prior experience in this area and to provide insights for experts in related research fields. Due to the pedagogical nature of the original lectures and the intense discussions between the lecturers and the students, the written lectures included in this volume often contain techniques and explanations not found in more formal journal publications. Contents: Introduction (J N Bahcall) Distribution of Dark Matter in the Spiral Galaxy NGC 3198 (T S van Albada et al.) Some Possible Regularities in Missing Mass (J N Bahcall & S Casertano) Evolution of Globular Clusters and the Globular Cluster System — I (J P Ostriker & C Thompson) Positive Energy Perturbations in Cosmology — II (J P Ostriker & C Thompson) Dark Matter in Galaxies and Galaxy Systems (S Tremaine & H M Lee) Gravitational Lenses (R D Blandford & C S Kochanek) An Introduction to Inflation (W H Press & D N Spergel) WIMPS in the Sun and in the Lab (W H Press & D N Spergel) An Introduction to Cosmic Strings (W H Press & D N Spergel) A Departure from Newtonian Dynamics at Low Accelerations as an Explanation of the Mass-Discrepancy in Galactic Systems (M Milgrom) Dark Matter in Cosmology (A Aguirre) Readership: Astrophysicists, high energy physicists and advanced students. Keywords: Dark Matter; Dark Energy; Cosmology

Discoveries in astronomy challenge our fundamental ideas about the universe. Where the astronomers of antiquity once spoke of fixed stars, we now speak of whirling galaxies and giant supernovae. Where we once thought Earth was the center of the universe, we now see it as a small planet among millions of other planetary systems, any number of which could also hold life. These dramatic shifts in our perspective hinge on thousands of individual discoveries: moments when it became clear to someone that some part of the universe—whether a planet or a supermassive black hole—was not as it once seemed. *Secrets of the Universe* invites us to participate in these moments of revelation and wonder as scientists first experienced them. Renowned astronomer Paul Murdin here provides an ambitious and exciting overview of astronomy, conveying for newcomers and aficionados alike the most important discoveries of this science and introducing the many people who made them. Lavishly illustrated with more than 400 color images, the book outlines in seventy episodes what humankind has learned about the cosmos—and what scientists around the world are poised to learn in the coming decades. Arranged by types of discovery, it also provides an overarching narrative throughout that explains how the earliest ideas of the cosmos evolved into the cutting-edge astronomy we know today. Along the way, Murdin never forgets that science is a human endeavor, and that every discovery was the result of inspiration, hard work, or luck—usually all three. The first section of *Secrets* explores discoveries made before the advent of the telescope, from stars and constellations to the position of our own sun. The second considers discoveries made within our own solar system, from the phases of Venus and the moons of Jupiter to the comets and asteroids at its distant frontier. The next section delves into discoveries of the dynamic universe, like gravitation, relativity, pulsars, and black holes. A fourth examines discoveries made within our own galaxy, from interstellar nebulae and supernovae to Cepheid variable stars and extrasolar planets. Next Murdin turns to discoveries made within the deepest recesses of the universe, like quasars, supermassive black holes, and gamma ray bursters. In the end, Murdin unveils where astronomy still teeters on the edge of discovery, considering dark matter and alien life.

A student-active introduction to the key topics in astronomy, emphasizing inquiry learning so students will clearly understand our universe and the scientific method. 'Nature of Science' sections in each chapter encourage students to take on the role of a scientist and within-text questions require critical thinking through astronomy-based problems.

Astronomy is a science that thrives on new discoveries. Fueled by new technologies and novel theoretical insights, the study of the cosmos continues to change our understanding of the universe. We are pleased to have the opportunity to present in this book a representative sample of the known facts, evolving ideas, and frontier discoveries in astronomy today. *Astronomy Today* has been written for students who have taken no previous college science courses and who will likely not major in physics or astronomy. It is intended for use in a one- or two-semester, non-technical astronomy course. We present a broad view of astronomy, straightforwardly descriptive and without complex mathematics. The absence of sophisticated mathematics, however, in no way prevents discussion of important concepts. Rather, we rely on qualitative reasoning as well as analogies with objects and phenomena familiar to the student to explain the complexities of the subject without oversimplification. We have tried to communicate the excitement we feel about astronomy and to awaken students to the marvelous universe around us. Many of you—teachers and students alike—have given us helpful feedback and constructive criticism on earlier editions. From these, we have learned to communicate better both the fundamentals and the excitement of astronomy. Many improvements inspired by your comments have been incorporated into this new edition. Focus of the Fifth Edition From the first edition, we have tried to meet the challenge of writing a book that is both accurate and approachable. To the student, astronomy sometimes seems like a long list of unfamiliar terms to be memorized and repeated. You will indeed be introduced to many new terms and concepts in this course, but we hope you will also learn and remember how science is done, how the universe works, and how things are connected. In the fifth edition, we have taken particular care to try to show how astronomers know what they know, and to highlight both the scientific principles underlying their work and the process used in discovery. New and Revised Material Astronomy is a rapidly evolving field, and the three years since the publication of

the fourth edition of *Astronomy Today* have seen many new discoveries covering the entire spectrum of astronomical research. Almost every chapter in the fifth edition has been substantially updated with new information. Several chapters have also seen significant internal reorganization in order to streamline the overall presentation, strengthen our focus on the process of science, and reflect new understanding and emphases in contemporary astronomy. Among the many changes are: Expanded coverage throughout of the scientific method and how astronomers "know what they know." New part-opening essays to establish historical context for each section of the text. Updated material in Chapter 5 on adaptive optics, Keck, Subaru, Gemini, and the VLT; additional material on infrared and optical interferometry; new coverage of the *Chandra* and *Spitzer* missions. An introduction to solar-system formation in Chapter 6, to better frame the discussion of planetary properties that follows. New material in Chapter 7 on the Ozone Hole and Global Warming. Expanded coverage in Chapters 6 and 10 of the most recent missions to Mars. Updates in Chapter 10 on Martian oppositions, gullies, oceans, and ice. Final update on the *Galileo*/*GEM* mission in Chapter 11. Coverage of *Stardust*, new Kuiper belt objects, and Pluto's status as a planet in Chapter 14. Updated discussion of solar system formation in Chapter 15; expanded coverage of competing theories, planet migration, planetesimal ejection, plutinos, and the angular momentum problem. New sections in Chapter 15 on extrasolar planets, with updated material on the latest observations and their implications for the condensation theory of solar system formation. Reorganization of presentation in Chapter 16, and an update on neutrino oscillations. New information on star names and revised coverage of key concepts in Chapter 17. Consistent and up-to-date stellar properties in Examples throughout Part 3. Updated information in Chapter 19 on brown dwarfs; new material on competitive accretion and collisions in star formation. New coverage in Chapter 20 of the end-states of stellar and binary evolution; more examples of familiar stars in specific evolutionary stages. Updated coverage of pulsars and gamma-ray bursts in Chapter 22. Reorganized and expanded material in Chapter 22 on Special and General Relativity and their historical development. Latest results in Chapter 23 on Sgr A* and the Galaxy's central black hole. Reorganization of Chapters 24 and 25, updating all coverage, emphasizing the connection between normal and active galaxies, and expanding the discussion of black holes in galactic nuclei. Updated discussion in Chapter 24 of the measurement of Hubble's constant. Expanded and substantially revised coverage in Chapter 25 of galaxy collisions, hierarchical merging and galaxy evolution; revised discussion of active galaxy evolution. Consistent distances and times in Chapters 24-27, assuming a flat universe with dark matter and dark energy as determined by the WMAP satellite; incorporation of results from recent sky surveys. Extensive revision of Chapters 26 and 27 to include the most recent observations of cosmic acceleration and discussion of "dark energy." Revised discussions of the cosmological constant and the age of the universe; results from the CBI and 97AMP experiments suggesting a flat universe. Updated coverage of Europa, Mars, interstellar organic molecules, extrasolar planets, and SETI in Chapter 28. Expanded Glossary which now includes many additional terms used in the text, but not identified explicitly as keywords. New detailed Seasonal Star Charts, courtesy of *Astronomy Magazine*.

Compound Art. It is rare that a single image, be it a photograph or an artist's conception, can capture all aspects of a complex subject. Wherever possible, multiple-part figures are used in an attempt to convey the greatest amount of information in the most vivid way: Visible images are often presented along with their counterparts captured at other wavelengths. Interpretive line drawings are often superimposed on or juxtaposed with real astronomical photographs, helping students to really "see" what the photographs reveal. Breakouts—often multiple ones—are used to zoom in from widefield shots to closeups so that detailed images can be understood in their larger context. The Illustration Program Visualization plays an important role in both the teaching and the practice of astronomy, and we continue to place strong emphasis on this aspect of our book. We have tried to combine aesthetic beauty with scientific accuracy in the artist's conceptions that adorn the text, and we have sought to present the best and latest imagery of a wide range of cosmic objects. Each illustration has been carefully crafted to enhance student learning; each is pedagogically sound and tied tightly to the nearby discussion of important scientific facts and ideas. Full Spectrum Coverage and Spectrum Icons. Astronomers exploit the full range of the electromagnetic spectrum to gather information about the cosmos. Throughout this book, images taken at radio, infrared, ultraviolet, X-ray, or gamma-ray wavelengths are used to supplement visible-light images. As it is sometimes difficult (even for a professional) to tell at a glance which images are visible-light photographs and which are false-color images created with other wavelengths, each photo in the text is provided with an icon that identifies the wavelength of electromagnetic radiation used to capture the image and reinforces the connection between wavelength and radiation properties. Explanatory Captions. Students often review a chapter by "looking at the pictures." For this reason, the captions in this book are often a bit longer and more detailed than those in other texts. H-R Diagrams and Acetate Overlays. All of the book's H-R diagrams are drawn in a uniform format, using real data. In addition, a unique set of transparent acetate overlays dramatically demonstrates to students how the H-R diagram helps us to organize our information about the stars and track their evolutionary histories. Other Pedagogical Features As with many other parts of our text, instructors have helped guide us toward what is most helpful for effective student learning. With their assistance, we have revised both our in-chapter and end-of-chapter pedagogical apparatus to increase its utility to students. Learning Goals. Studies indicate that beginning students have trouble prioritizing textual material. For this reason, a few (typically 5 or 6) well-defined Learning Goals are provided at the start of each chapter. These help students structure their reading of the chapter and then test their mastery of key facts and concepts. The Goals are numbered and cross-referenced to key sections in the body of each chapter. This in-text highlighting of the most important aspects of the chapter also helps students review. The Goals are organized and phrased in such a way as to make them objectively testable, affording students a means of gauging their own progress. Concept Links. In astronomy, as in many scientific disciplines, almost every topic seems to have some bearing on almost every other. In particular, the connection between the astronomical material and the physical principles set forth early in the text is crucial. Practically everything in Chapters 6-28 of this text rests on the foundation laid in the first five chapters. For example, it is important that students, when they encounter the discussion of high-redshift objects in Chapter 25, recall not only what they just learned about Hubble's law in Chapter 24 but also refresh their memories, if necessary, about the inverse-square law (Chapter 17), stellar spectra (Chapter 4), and the Doppler shift (Chapter 3). Similarly, the discussions of the mass of binary-star components (Chapter 17) and of galactic rotation (Chapter 23) both depend on the discussion of Kepler's and Newton's laws in Chapter 2. Throughout, discussions of new astronomical objects and concepts rely heavily on comparison with topics introduced earlier in the text. We remind you of these links so you can recall the principles on which later discussions rest and, if necessary, review them. To this end, we have inserted "Concept Links" throughout the text—symbols that mark key intellectual bridges between material in different chapters. The links, denoted by the symbol together with a section reference, signal that the topic under discussion is related in some significant way to ideas developed earlier, and provide direction to material to review before proceeding. Key Terms. Like all subjects, astronomy has its own specialized vocabulary. To aid learning, the most important astronomical terms are boldfaced at their first appearance in the text. Each boldfaced Key Term is also incorporated in the appropriate chapter summary, together with the page number where it was defined. In addition, an expanded alphabetical glossary, defining each Key Term and locating its first use in the text, appears at the end of the book. Concept Checks. We incorporate into each chapter a number of "Concept Checks"—key questions that require the reader to reconsider some of the material just presented or attempt to place it into a broader context. Answers to these in-chapter questions are provided at the back of the book. End of Chapter Questions and Problems. Many elements of the end-of-chapter material have seen substantial reorganization: Each chapter now incorporates 20 Conceptual Self-Test Questions, equally divided between "true/false" and multiple choice formats, allowing students to assess their understanding of the chapter material. Answers to questions appear at the end of the book. Each chapter also has 20 Review and Discussion Questions, which may be used for in-class review or for assignment. As with the Self-Test Questions, the material needed to answer Review Questions may be found within the chapter. The Discussion Questions explore particular topics more deeply, often asking for opinions, not

lust facts. As with all discussions, these questions usually have no single "correct" answer. The end of chapter material includes 15 Problems, based on the chapter contents and entailing some numerical calculation. In many cases the problems are tied directly to quantitative statements made (but not worked out in detail) in the text. The solutions to the Problems are not contained verbatim within the chapter, but the information necessary to solve them has been presented in the text. Answers to odd-numbered Problems appear at the end of the book. Discovery Boxes. Exploring a wide variety of interesting supplementary topics, these features have been expanded and provide the reader with insight into how scientific knowledge evolves, and emphasizing our theme of the process of science. More Precisely Boxes. These provide more quantitative treatments of subjects discussed qualitatively in the text. Removing these more challenging topics from the main flow of the narrative and placing them within a separate modular element of the chapter design (so that they can be covered in class, assigned as supplementary material, or simply left as optional reading for those students who find them of interest) will allow instructors greater flexibility in setting the level of their coverage. Interactive eBook. The Astronomy Today, Fifth Edition interactive eBook is located in the WebCT, BlackBoard, and OneKey courses and has been redesigned for easier and clearer navigation. It contains a full electronic version of the text, with key term hyperlinks and imbedded media elements at point of use. The eBook features: New! Tutorials: Written by Philip Langill (University of Calgary). These animated, interactive Flash™ files, denoted by an icon in the text, allow students to explore the ideas and concepts from the text in depth. Students are engaged in the thought process as they answer questions and change parameters in these exploratory activities. New! Physlet(tm) Illustrations for Astronomy: Written by Chuck Niederriter and Steve Mellema (both of Gustavus Adolphus College); Physlets by Wolfgang Christian (Davidson College). Through animation, these brief Java applets, denoted by an icon in the text, further illustrate concepts from the text. Each Physlet is followed by a series of questions that encourage students to think critically about the concept at hand. 61 narrated videos and animations imbedded within the text, at point of use. These help to bring text figures and concepts to life. All bold key terms in the text are hyperlinked to a glossary definition and an audio pronunciation. Student Accelerator CD-ROM. The Student Accelerator CD-ROM that is packaged with Astronomy Today, Fifth Edition contains the Tutorials, Physlet(tm) Illustrations, animations, and videos from the eBook. The CD accelerates the performance of the eBook when students download the high-bandwidth media, so that students are not restricted by slow connections. It can also be used apart from the eBook if a student doesn't have a live Internet connection or just wants to view the media elements. Companion Website. (<http://astro.prenhall.com/chaisson>) The text-specific Companion Website for Astronomy Today, Fifth Edition organizes material from a variety of sources on the web on a chapter-by-chapter basis, is updated regularly, and provides interactive exercises for each chapter. It includes: Annotated images, videos, and animations that are regularly updated to reflect the most recent astronomical discoveries. Interactive multiple-choice quizzes with hints and instant feedback. Algorithmically generated versions of the end-of-chapter problems from the text. Links to associated websites that are regularly updated for currency and relevancy.

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