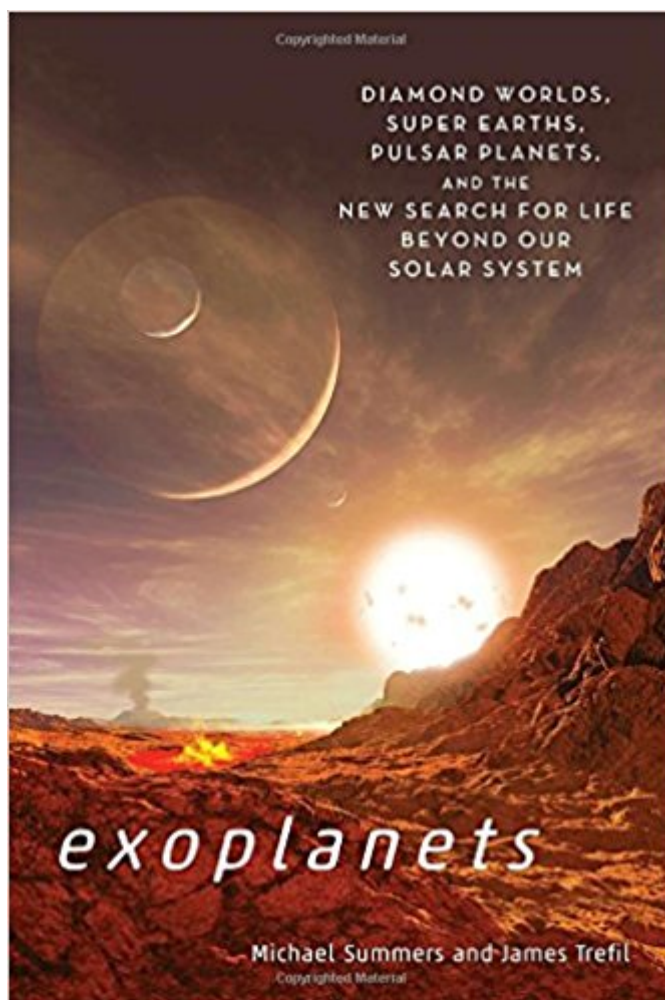


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# Exoplanets: Diamond Worlds, Super Earths, Pulsar Planets, And The New Search For Life Beyond Our Solar System



## Synopsis

The past few years have seen an incredible explosion in our knowledge of the universe. Since its 2009 launch, the Kepler satellite has discovered more than two thousand exoplanets, or planets outside our solar system. More exoplanets are being discovered all the time, and even more remarkable than the sheer number of exoplanets is their variety. In *Exoplanets*, astronomer Michael Summers and physicist James Trefil explore these remarkable recent discoveries: planets revolving around pulsars, planets made of diamond, planets that are mostly water, and numerous rogue planets wandering through the emptiness of space. This captivating book reveals the latest discoveries and argues that the incredible richness and complexity we are finding necessitates a change in our questions and mental paradigms. In short, we have to change how we think about the universe and our place in it, because it is stranger and more interesting than we could have imagined.

## Book Information

Hardcover: 224 pages

Publisher: Smithsonian Books (March 14, 2017)

Language: English

ISBN-10: 1588345947

ISBN-13: 978-1588345943

Product Dimensions: 6.3 x 0.9 x 9.3 inches

Shipping Weight: 1.1 pounds (View shipping rates and policies)

Average Customer Review: 4.5 out of 5 stars 23 customer reviews

Best Sellers Rank: #43,153 in Books (See Top 100 in Books) #56 in [Books > Textbooks > Science & Mathematics > Astronomy & Astrophysics](#) #69 in [Books > Science & Math > Astronomy & Space Science > Cosmology](#) #71 in [Books > Science & Math > Astronomy & Space Science > Astrophysics & Space Science](#)

## Customer Reviews

**BOOKLIST, Starred Review** The existence of planets outside Earth's solar system was long assumed, and recent technologies, including improved telescopes and research satellites, have not only confirmed their existence but revealed all kinds of surprises. The first verified exoplanet, for instance, was orbiting "the wrong kind of star," a pulsar, or what was left after a supernova that was supposed to blast to smithereens anything even close to resembling a planet. Meanwhile, the statuses of solar system objects besides the recognized planets were

changing as water, indispensable for Earth-like life, was detected as superficial ice and subsurface oceans on some moons of Jupiter, Saturn, and Neptune as well as on big bodies in the Kuiper Belt, such as the demoted planet Pluto, which thereby regained its title. Astonishment continued as huge, rocky “Super Earths,” inexplicably light planets, pure-carbon diamond planets, planets circling more than one star, starhugging hot planets, and rogue planets unconnected to stars were detected. These revelations, how they were made, imaginative voyages to five un-Earthly types of planet, and their implications for life and intelligence elsewhere than on Earth are concisely illuminated by astrophysicists Summers and Trefil in this marvelously fascinating and wonderfully accessible illustrated book.

• Ray Olson

**PUBLISHERS WEEKLY** Readers tour several bizarre worlds in this slim read, as Summers and Trefil, professors of physics at George Mason University, show how “defining a ‘planet’ has been made significantly more difficult in the exoplanet age. Astronomical investigations outside our celestial backyard are ripe with paradigm shifts because scientists suffered “the curse of the single example”: our solar system and carbon-based life. Detailed photos and illustrations aid “visits to unusual worlds, including 55 Cancri e, where volcanoes spew liquid diamond; Kepler 186f, with its vast lagoons and black flora that absorb “what energy they can from the faint sun; and a rogue planet wandering dark space, where any life “must see in the infrared and be warmed by the planet’s core. The authors temper runaway imaginations with scientific uncertainties about each location, and they reexamine the Drake equation “used in the search for extraterrestrial life “in light of our current understanding of exosystem frequency and dynamics. Summers and Trefil write confidently and straightforwardly for lay readers, who will long ponder what planets circle other suns and the peculiar possibilities of life beyond our blue marble. **ILLUSTRATIONS**

**KIRKUS REVIEW** A comprehensive introduction to the thousands of newly discovered planets beyond our solar system, which are beautiful and mind-bending in their diversity “and those are just the ones we know of. Though astronomers had long predicted that there were other solar systems out there, only in the past decade has satellite telescope technology been able to confirm the existence of an enormous number of exoplanets, “planets outside our solar system. Even more significant than their abundance is their diversity, and even more astonishing than their diversity is, in some cases, their very existence “many of these worlds defy what scientists thought they knew about what was possible about how planets form and behave. Planetary scientist Summers (Physics and Astronomy/George Mason Univ.), who has been a member of multiple NASA mission teams, and Trefil (Physics/George Mason Univ.; *Space Atlas: Mapping the Universe and Beyond*, 2016, etc.)

take readers on an exhilarating tour of the universe as we now know it. In a series of chapters that detail a variety of recently detected planets, the authors provide both a history of exoplanet discovery and a look toward the future of the field (which just may bear fruit in the search for extraterrestrial intelligence). “If there really are rogue planets floating around just outside the solar systems,” they write, then perhaps “multigenerational starships won’t be needed to reach them.” These otherworldly planets are dizzying in scope and are a wonderful feast for the imagination, even as the authors back up their imagery with the latest research findings. Also included are a number of photographs and illustrations that provide a welcome visual accompaniment to the lay-friendly text. Space enthusiasts of all ages will enjoy this exploration into the farthest reaches of the universe and the cutting edge of astronomical research. CHOICE Summers and Trefil (both, George Mason Univ.) have written a short, entertaining book about the huge variety of extrasolar planetary types, many of which were not even dreamt of a decade ago. The authors explore characteristics of some types discovered and extrapolated, such as worlds covered in ice and water, worlds with volcanoes that erupt diamonds, and some not yet seen, such as rogues ejected from planetary systems during formation to wander the galaxy without a star. The authors devote the most important part of the book to two questions: Is there life elsewhere and can we recognize it? If so, is there intelligent life? They posit that the first question may be answered in the affirmative soon, as new telescopes begin the necessary observations. Yet the question about intelligent life may never be answered. The book has been written to avoid the obsolescence that rapid progress can bring about in this field.

MICHAEL SUMMERS is a planetary scientist and professor of physics and astronomy at George Mason University. Since 1989, he has served on the mission teams of several NASA space probes in the role of science planning and interpretation of spacecraft observations. He is currently a coinvestigator on the NASA New Horizons mission to the Pluto-Charon double planet, where he serves as the deputy lead of the Atmospheres Theme Team. JAMES TREFIL is Clarence J. Robinson Professor of Physics at George Mason University. He has written more than 50 books on science for a general audience. His writing has won the American Institute of Physics Science Writing Award, the American Association for the Advancement of Science Westinghouse Science Journalism Award, and other honors.

One of the most interesting and thought provoking books I have read in a long time. Written by scientists in a way that most everyone should be able to understand.

Excellent! Exceeded all expectations! I was intrigued from word one. Will read it again!

This is a non-technical survey of exoplanet research. The authors write in an almost breezy, accessible style, telling us, first the basics of exoplanets, how they are detected, what the current state is, and then they go into a kind of tour guide to some example types of exoplanets. The book concludes with short chapters on the Drake Equation, the search for intelligence, and the Fermi Paradox. That's a lot to cover in a little over 200 pages, so don't expect too much depth on any one thing. I've been following exoplanet research for some time, but I always find revisiting the facts and reasoning behind it a good use of time. It's a chance to climb out of the middle of debates and issues and get a fresh perspective. The first five chapters lay out basics, including a discussion of the definition of a planet, detection methods, and a chapter on the Kepler mission. Chapters six through ten are speculative sketches of what five sample exoplanets are really like, imagining a close-up visit to them. The five include:- 55 Cancri E ("Diamond World"- "Haven", an imagined rogue planet (a planet no longer orbiting a star)- A Pluto-like "Ice World"- Kepler 186f ("Archipelago World" with a watery but not fully submerged surface and orbiting an M Dwarf star)- Gliese 1214b ("Water World") These chapters are entertaining, speculative, and tempered by explicit caveats about how much we can really know and how much is educated guessing. Those are followed by a discussion of life on earth and how it may have originated, as a guide to think about how the same (or something very different) might happen elsewhere. Then come short chapters on the search for life, the search for intelligent life, and a concluding discussion of the Fermi Paradox. All of these topics, of course, are treated in much more depth in other books. What you're getting here is strictly overview. The one theme that the authors really want to drive home is to caution our reasoning in light of "the curse of the single example". We have only one known example of a planet that supports life, one example of the origin and evolution of life, one example of a technological species (capable of interstellar communication), one example of a planetary system whose history and structure we have detailed knowledge of, . . . and so on. It's not just that we have little data to base our reasoning and speculation on, it's that that one example may implicitly limit our imaginations. The authors cite some good examples. One in which our limited imaginations have been busted is the recognition that rogue planets, cruising independently

through interstellar space far from any star, could provide environments rich enough in energy and heat to potentially support life. Others are drawn from science fiction – Isaac Asimov's vision of a composite life form, made of rocks or grains of sand connected in some non-apparent way, or a life form on Titan, with a metabolism so slow in its frigid environment, that it takes 1,000 years to draw a single breath. Are we sure we would really even recognize an alien life form as alive, much less intelligent? Time and again, as they point out, we are surprised. We were surprised by Pluto, that a planet so far from its star could generate enough internal heat to apparently host a subsurface ocean. We were surprised by the prevalence of subsurface oceans in moons of planets well outside of the sun's "habitable zone". It sounds like a cliché, but, as a warning against making premature conclusions about anything to do with exoplanets, the possibilities for life, and all the rest, we must always recognize that surprise is a constant in this field. Books in this field are guaranteed to be born out of date. You won't find anything here about Proxima B or the Trappist system of exoplanets. Those currently hot topics arrived too late for the authors to include. They do discuss Tabby's Star (the "alien megastructure" star). But there is just no way to keep up, given the time it takes to get a book to print. Readers who want the latest news and conjectures on those topics, and the latest on Kepler detections, are better off with online sources.

"Exoplanets" coming from "Smithsonian Books is neat. I thought I was a generally educated layman on astronomy among other things. Apparently, I've failed. For some reason I've missed much of the last 10 years of Hubble and Kepler, astronomy findings and interpretation. What's next in upsetting our older universe. Simply, I'm out of date. Where can I begin? Simply much of what we laypeople learned in school/college is outdated by new cosmological theories and interpretation. I do not know what is being taught on campuses today. but dig into this book. Our Solar System? Nine planets? – Fear not. Beginning with Pluto there are hundreds of thousand mini-planets in the outer system. Moons? Many more than we ever thought. Where's the water? Not in the inner system but the outer system. Much is free water of some type under ice. All sorts of possibilities both in system and out. Rouge planets - those flitting thru space without any connection to a star or an orbit. Now I learn plate tectonics among other methods can keep some of them warm and life is possible. There may be more of these than solar systems and planets throughout the universe. The search is just beginning. Now I understand some of the recent SF about rough landings on rouge planets with

humans surviving and spreading. New ideas, new directions. Planets? some very strange things. There is a planet circulating its sun in 17 hours. It is within the outer edge of the star's photosphere. It is dark. Formation theories? Change is the normal order of the day. And the future, searching for life on different forms of planets raises new ideas. The issues are the how and the what - all hypotheticals. A good introduction. I rate this book a five. However I can't figure out if this book is for AP Science, college introductory astronomy or just a general read for all us "uneducated" adults.. Your choice.

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