
My Review:
I saw this book at Mary Scorer soon after it was published in 1994, at a time when my work on dimensions in physics, and in classification, was a preoccupation. Kaku’s Hyperspace strongly resonated with my interests at that time and I refer to it frequently. In it he deals with the difficult issue of higher spatial dimensions, aiming for the ten needed in contemporary physics. We live in three spatial dimensions (Descartes’ x, y, z). Kaku starts out with a consideration of those familiar to us by discussing the late 19th century fascination with going beyond the “3” to the 4th spatial dimension, developing ideas by considering one and two dimensions along the lines of Abbott’s “Flatland” epic study, and other discussions by physicists and clerics. Riemann had set the mathematical basis in a lecture in 1854, but there may have been earlier work (Dante?). I gave a series of lectures from 1995 to 1999 to high school math students which used some of the early illustrations. There has been a growing interest in parallel universes and wormholes in spacetime over the past decade, so much so that in recent years there have been several science fiction series on TV built around these of the ideas.

The early history is beautifully set out, owing much to the much more academic study of Linda Dalrymple Henderson (in the Fine Arts library) on four dimensions. The illustrations follow a tradition begun by George Gamow and continued by Carl Sagan (Cosmos). Who will forget Gamow’s two dimensional projection of a horse, or Kaku’s two dimensional digestive system of a bird? Kaku makes links with the work of Picasso and Dali, a theme in Henderson, which also continues with Leonard Shlain’s “Art and Physics”.

Kaku uses Einstein in several sketches to clarify critical ideas, e.g the projection from three dimensions to two using a flashlight and a wire frame cube. [demonstrate]

On page 41 Kaku shows Riemann’s four-by-four metric tensor which is used in Einstein’s General Theory of Relativity, as familiar to theorists as Einstein’s E=mc^2 is to everybody else, and later on page 102 Kaku shows the critical step in its enlargement to five-by-five using Kaluza’s brilliant idea of 1919 (published about 1922) as a way to combine it with Maxwell’s equations of electromagnetism. Essentially this is the first step in enlarging the number of spatial dimensions to ten, which is counted as 1 from Kaluza’s idea, plus 3 each from x, y and z, as each consists of one normal unfolded dimension and two tightly wrapped ones.

By “painting” a tensor matrix Kaku brilliantly shows the reader some of the symbolism in the working tools of theoretical physicists without getting into unnecessary detail, something shared with some other singular books such as our Icon book on “Introduction to Quantum Theory” by McEvoy and Zarate.
Part II on page 111 is titled “Unification in Ten Dimensions”. This part introduces quantum theory into the picture, including the obligatory two-slit problem and quickly gets to quarks. This section ends with some cosmology which includes black body radiation (Planck) and the recent observations of the COBE satellite. There is also a visual attempt to discuss periodic boundary conditions using the geometry of a torus (bagel) and a reference to video games.

Part III from page 217 gets into the more speculative stuff about wormholes and so on.

Quote: About one third of the way through the book is a statement which we should value:

“In the history of physics, no one had found any use for the fourth spatial dimension. Ever since Riemann, it was known that the mathematics of higher dimensions was one of breathtaking beauty, but without physical application.”

Such excerpts can be found by an online search via an Amazon online index searching for “fourth spatial dimension”: 
http://www.amazon.com/gp/reader/0195085140/ref=sib_dp_srch_pop/103-1092527-6684624?v=search-inside&keywords=history+of+physics&go.x=0&go.y=0&go=Go%21

[N.B. this is not an option for many books]

There are fifteen pages of valuable notes at the end of the book which take the reader into more detail.

I found Kaku’s book much more useful than Pickover’s “Surfing through Hyperspace”. It is sometimes unclear what Pickover is trying to say, though I found his book on magic squares quite useful.

THE AUTHOR: Professor Kaku grew up in New York City where he is now at the City College of New York, is an expert on string theory [Strings, Conformal Fields, and M-Theory. Graduate Texts in Contemporary Physics. 2nd edition. M. Kaku. Springer-Verlag, New York, 2000 [1991]. 531 pp. $69.95 hc ISBN 0-387-98892-0], and also spends a lot of effort communicating via a radio program. He has several very well received books aimed at a broad scientific audience (do you read science articles in your local and national newspapers and magazines?), and was recently interviewed on Quirks and Quarks for the World Year of Physics 2005 (a.k.a. The Einstein Year). 
http://www.cbc.ca/quirks/archives/04-05/jan08.html
AUTHOR’S WEBSITE: http://www.mkaku.org/

Question: Why “quarks”?

Reviews: (these are all complimentary reviews of a very successful book)
1. Physics World: “Journey to the dimensions of the world”, Reviewer: Luciano Maiani, Professor of theoretical physics at the University of Rome, La Sapienza, Italy, and head of Istituto Nazionale di Fisica Nucleare.


BLACK HOLES first widely appeared on the astronomical landscape about 30 years ago and still excite much interest. Scientists continue to follow the claims of black holes in active galactic nuclei and the slow accretion of more candidates for stellar-mass black holes. More recently, the television series Star Trek: Deep Space Nine has introduced a wider community to their more speculative cousins, wormholes. Kip Thorne and Michio Kaku, both well-established scientists, seek to introduce, inspire, and inform popular audiences about these topics. Thorne describes the revival of research in general relativity that began in the 1960s and continues to this day. Kaku ventures into the higher-dimensional world that contains present-day theories of particle physics.

Einstein's equations contain a mathematical solution in which an intrepid astronaut can enter a black hole, discover a tunnel in it, and come out in another part of the universe. Such a solution describes a wormhole. For years, most scientists neglected wormholes as mathematical curiosities, since no one could see how natural processes like the collapse of stars could make them. Carl Sagan's science-fiction novel Contact inspired Thorne and his students to explore another kind of wormhole: one that an advanced civilization would build using colossal astroengineering. Thorne and his collaborators published several papers on wormholes in physics journals; they made this field of research respectable. It became a cottage industry with about a half dozen scientists publishing occasional technical papers.

Thorne's authoritative, encyclopedic book challenges the reader. Its mass and volume rival those of a small concrete block. It packs a lot of information and concepts per page, just as a concrete block packs many pebbles and grains per cubic inch. For example, Thorne devotes 10 pages to special relativity and introduces it through space-time diagrams. I have taught special relativity to thousands of nonscience majors. Even the intellectually quick students need more than 10 pages. They tell me that space-time diagrams make learning relativity quite abstract. So I wouldn't use this book in my
courses for nonscience majors. The dry writing style resembles that of mathematical physics research papers. The passive voice, the wimpy verb "to be," and its high-falutin mathematical equivalents like "is shown" dominate Thorne's vocabulary. I believe most Sky & Telescope readers will find it a tough read, though more accessible than Stephen Hawking's blockbuster A Brief History of Time.

Readers who surmount this challenge will find valuable rewards at the end. Thorne organizes his treatment of black holes historically, and you should not be put off by a few small errors in the chronology of the 18th and 19th centuries. Thorne's discussion of Einstein's miracle year of 1905 -- when he discovered relativity, the photoelectric effect, and an explanation for Brownian motion -- beats any other history of the period I've read. Thorne thinks in the same way that Einstein did and so can lead you along Einstein's path.

Thorne's description of the last 30 years of general-relativity research has lasting value as a classic. He interviewed many of his colleagues about the history of their discipline. I know of no other researcher who has done that. He recorded Hawking's infamous bets and reprints them. Hawking loves to focus scientific controversy by betting on science issues. For instance, do black holes really exist in double star systems like Cygnus X-1? (Yes.) Do Einstein's equations permit the existence of naked singularities, or must space-time singularities always clothe themselves in event horizons? (Most likely, naked singularities don't exist but the bet remains open.) This rich narrative tapestry leads you through the complexities that constitute today's astronomy, with its fascinating objects, gravitational waves, wormholes, and the like.

Kaku's background in particle physics gives his book Hyperspace a different focus. For some time particle physicists have sought to use higher-dimensional universes as a way to explain the veritable zoo of forces and particles that dominate our universe at the microscopic level. A universe that looks quite simple and comprehensible in 11 dimensions becomes much more complex when we reduce it to the four dimensions that human beings can perceive (three of space and one of time).

Hyperspace then leads the reader through the last two decades of particle physics research. Kaku has a remarkable sense for the beauty of particle physics and uses analogies with other splendid things such as symphonies and poetry to communicate this beauty and simplicity to someone who does not understand the deep mathematics of the theory. The Standard Model, which can explain the properties of all the known particles, lacks the symmetry and beauty that must be present in the ultimate theory for the particles and forces we see in nature. Kaku explains string theory more clearly than any other popular exposition I've seen.

Kaku's book arrives with half the weight, slightly over half the page count, and a considerably lower information density than Thorne's. While it, too, occasionally challenges the reader, most particularly in the chapter on the revival of Kaluza-Klein models, I believe that most Sky & Telescope readers will find it more accessible. Kaku uses mostly active verbs. However, I don't understand why he included the last few chapters, which ramble pointlessly through a la-la land of extraterrestrial civilizations, the connection between science and religion, holism, Alar, and other miscellaneous topics that have no connection with the rest of the book. Did some editor tell him that the book would not sell if it were less than 300 pages long?

Just as Thorne's book traces his personal odyssey, developing his scientific career by
journeying to Moscow and other exotic places, Kaku lends a personal touch to his exposition too. The Vietnam War draft forced Kaku into the army. He provides a marvelous recollection of how he worked out a lot of string-theory calculations during infantry training, crawling through brown mud and dodging real bullets. He somehow managed to complete advanced machine-gun training, do the calculations for a Ph.D. dissertation, and stay alive and unhurt at the same time. Wow!

Both Thorne and Kaku devote one or two chapters to wormholes. Thorne covers much more ground and provides a reasonably complete picture of what's going on. Kaku devotes more space to the difficulties of using wormholes as time machines and less to their basic properties. As a result, he leaves a lot of gaps in the story.

So, if you really want to learn about wormholes, choose Thorne's book, though you might also want to consider Paul Halpern's Cosmic Wormholes, a more-readable but less-complete text than Thorne's. But if your horizons extend beyond these hypothetical, futuristic space-transportation systems, either book takes you on a personal journey through a fascinating landscape.

Added material
Shipman works in the Science Education Department at the University of Georgia, on leave from his home institution, the Physics and Astronomy Department at the University of Delaware. He has written four popular books on astronomy and the space program.

HYPERSPACE
Top: Kip Thorne muses that a suitably advanced civilization could draw a vast amount of power from the electromagnetic environment of a rotating black hole, as this fanciful illustration suggests.

Above: To help illustrate a point in Black Holes and Time Warps, Thorne crawls through a small wormhole -- and lives.

Are we really in a universe, or are there an infinite number of other universes, perhaps interconnected by wormholes? Even if the latter is the case, in his book Hyperspace Michio Kaku predicts that interuniversal travel is improbable.

FOOTNOTE
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* From Kirkus Reviews
Kaku (Physics/CCNY) is the author (with Jennifer Trainer) of Beyond Einstein (1987) and of several popular volumes on advanced physics. He is also the host of a weekly radio program on modern science. Here, he offers a popular explanation of how the mathematics of higher dimensions underlies modern physical theories, notably the superstring hypothesis of how the universe is put together. The great problem confronting physics has been the building of a bridge between relativity and quantum theory: a single theory reconciling the two extremes of the very large and the very small. Relativity is proven beyond doubt on the scale of planets and galaxies; quantum theory applies to the microcosmic world of subatomic particles. Ever since Einstein, physicists have been trying, and failing, to combine the two into a GUT (Grand Unified Theory). Although it remains controversial among physicists and cosmologists, Kaku proffers superstring theory as the best approximation yet--but it requires acceptance of a counter-intuitive
system in which our sensory world, hosting three dimensions of space and one of time, is only a small part of a universe containing ten dimensions (six of them undetectable by our limited senses). Higher dimensions, aka hyperspace, seem to some physicists the most consistent description of the universe we actually inhabit, and to others just one more futile attempt to unify relativity and quantum theory. Kaku admits the futility of visualizing a ten-dimensional universe with our three-dimensional mindset; in fact, he admits that the mathematics of superstring theory are so difficult that many of the key equations remain unsolved. But he effectively marshals examples from everyday experience and the labors of working scientists to illuminate current theories of how the universe really works (to the extent that anyone can understand it without working the equations), offering intelligent speculations on how time travel and faster-than-light travel might be possible. Kaku's explanations of the principles of superstring theory are lucid, lively, and full of entertaining glimpses of the researchers involved. A worthy successor to the popular physics texts of George Gamow, as thought-provoking as Stephen Hawking. -- Copyright ©1994, Kirkus Associates, LP. All rights reserved. --This text refers to the Hardcover edition.