

Brush up your bosons

Particle Physics for Regular People

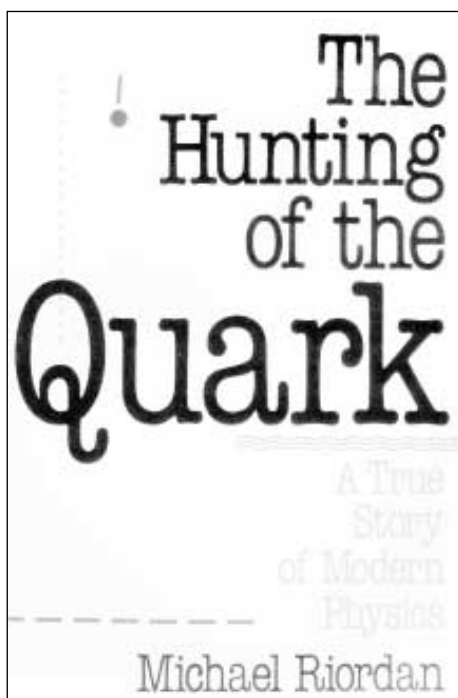
By Mike Perricone, Office of Public Affairs

Psychologist Oliver Sacks has Robin Williams portraying him on screen. Cosmologist Carl Sagan's fictional heroine explores the universe in the glamorous guise of Jodie Foster. Biologist Stephen Jay Gould muses about the Red Sox in the PBS megadocumentary "Baseball."

Where are all the particle physicists?

They're on a high-energy bookshelf near you.

The authors of the best plain-language literature in particle physics might not yet have reached stardom, but their books offer a literate, accessible and engaging introduction to a field of science that has been known to intimidate the uninitiated. The stories of the discoveries of the particles at the heart of matter offer all the thrills of a good chase—one of the biggest chases of 20th-century science. From the wide field available, readers can start with a half dozen of the "best of the best" books for gaining an understanding of the reason for all the excitement.



Take your cue from Leon Lederman, 1988 Nobel laureate and former director of Fermilab. And take a clue to his approach from his witty title—"THE GOD PARTICLE: If the Universe Is the Answer, What Is the Question?"

Prompted by an imaginary dialogue with the classical Greek mathematician-philosopher Democritus, whom he calls "the first particle physicist," Lederman leads us on a trail that begins with the smell of baking bread in ancient Greece and culminates in the quest for the Higgs boson, the "God particle" of the title—so-named, Lederman says, because it is "so central to the state of physics today, so crucial to our final understanding of the structure of matter, yet so elusive."

It's easy enough to focus on Lederman's humor and zero in on his groaning board of puns. Example: When the Greek philosopher uses a knife to halve a piece of cheese innumerable times, the result is a "feta-compli." Groan.

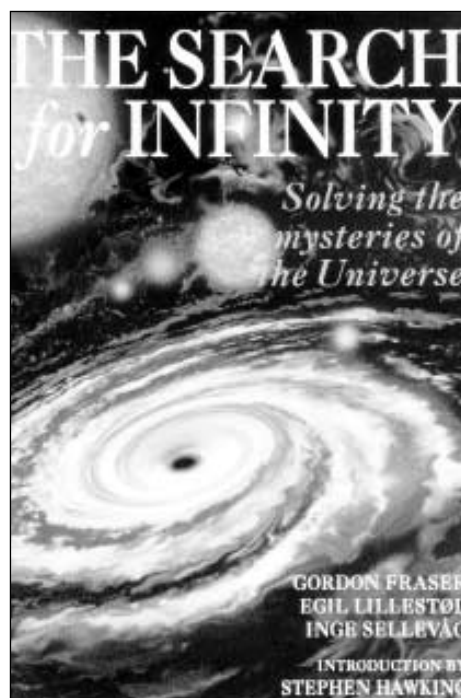
But the prime significance of "The God Particle," and the power of its appeal as an introductory work, lies in the clarity of Lederman's explanations, the sense of his comparisons, the tangible and unbreakable thread of the story through time and his own experience.

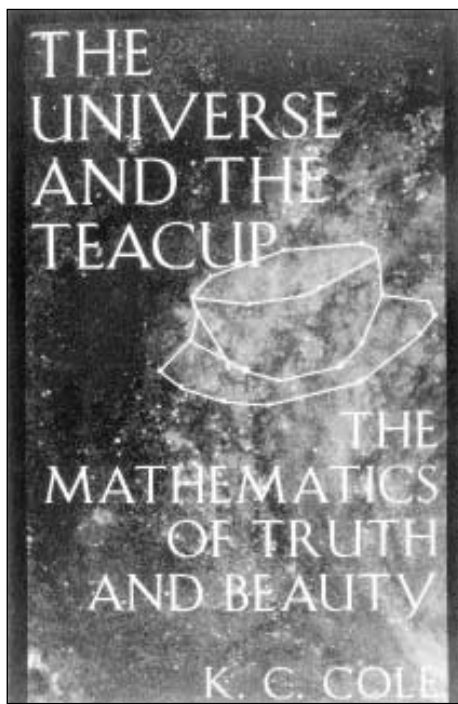
Another veteran of the chase is Michael Riordan, who is also one of the best chroniclers in "THE HUNTING OF THE QUARK: A True Story of Modern Physics."

If you're a mystery fan, this is the "police procedural" of the particle physics era—the background, the evidence, the investigators, the relentless and systematic pursuit, the false trails and surprises, the accidental discoveries, and the sense of groping that seems to be absent in many treatments of science. Riordan covers the 20-year search for the quark, from the first intimations in the 1960s to the series of discoveries in the

1970s that made the quark "real." Riordan's goal is to show "how our mental image of the subatomic world was transformed between 1964 and 1980."

You must form a mental image before you can transform it, and you'll find spectacular introductory images in "THE SEARCH FOR INFINITY: Solving the Mysteries of the Universe," by the European team of Gordon Fraser, Egil Lillestøl and Inge Sellevåg. Illustrated as impressively as any coffee-table book, "The Search for Infinity" begins by "Looking In" (The Exploration of Matter), and concludes by "Looking Out" (Understanding the Universe). The excellent overviews of particle physics and astrophysics are enlivened with vignettes of the scientists associated with them. Wolfgang Pauli, who first predicted the existence of the neutrino, supposedly once offered encouragement to a colleague who was distraught after finding an error in his own work. "Everybody makes mistakes," Pauli said sympathetically. "Except me."





Not as colorful as “The Search for Infinity,” but at least as valuable, is “THE PARTICLE EXPLOSION,” by Frank Close, Michael Marten and Christine Sutton. Focusing exclusively on the subatomic realm, “The Particle Explosion” is a primer on atomic structure and each of the known particles. It also includes a powerful secret weapon: an exhaustive Table of Particles, charting each particle’s physical properties, its history of discovery (and discoverers) and its role in matter, all keyed to the appropriate sections of the text. The Table is the kind of reference you’ll want to keep in an honored (and secure) place and hand down to the next generation, especially if there’s an exam coming up.

There’s no physics without funding, and ultimately there’s no physics without mathematics. Award-winning science writer K.C. Cole has a new gem, “THE UNIVERSE AND THE TEACUP: The Mathematics of Truth and Beauty,” with the title offering a subtle resonance with the top (“truth”) and bottom (“beauty”) quarks.

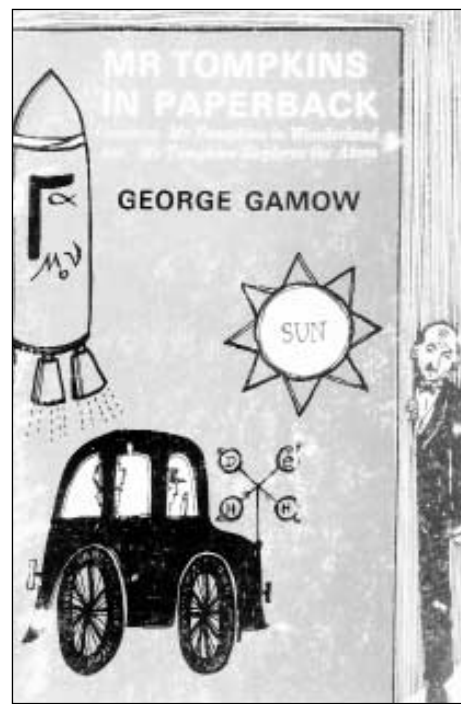
In counterpoint to the near-unanimous “maleness” of physics and its literature, Ms. Cole has a refreshing chapter on Einstein, relativity, and the little-known but critical contributions of Emmy Noether. A brilliant mathematician, Noether was refused a university position in Göttingen,

Germany, because she was a woman—though she had recommendations from eminent mathematician David Hilbert and from Einstein himself. But it was Noether who later gave credibility to relativity by proving mathematically that energy was conserved in four-dimensional space-time. So in a real sense, relativity, particle physics and Fermilab all owe their ongoing well-being to the work of Emmy Noether.

They also owe a debt to George Gamow, one of the originators of the big bang theory of the birth of the universe.

Gamow was one of the first popularizers of relativistic physics and quantum theory. He wrote two whimsical little books in the 1940s about a traveler, bank clerk C.G.H. Tompkins (c, for the speed of light; G, the gravitational constant; h, the quantum constant), in a realm of highly exaggerated relativity. “MR.

TOMPKINS IN WONDERLAND” and “MR. TOMPKINS EXPLORES THE ATOM” were later combined in a single slim volume, “MR. TOMPKINS IN PAPERBACK,” that was still being used as a supplementary college text in the 1960s and 1970s—and it’s still going strong. Some of the language is amusingly antiquated, and Gamow would certainly be surprised at today’s take on his chapter entitled “The Gay Tribe of Electrons.” But “Quantum Billiards” has a collision between two billiard balls resulting in “innumerable balls, all of them very vague and gruelly...rushing about within an angle



of 180 degrees round the point of impact.” And “Cosmic Opera” matches expansion vs. steady-state theories in contesting arias. Dated, yes; but musty old Mr. Tompkins is worth any allowances.

Lederman, Riordan, Gamow and company flavor their science with myth, mirth, poetry and history. They offer a high quality of armchair companionship when you unwind from the hunt at the end of day and consider the words of Democritus, that first particle physicist, who said 2,400 years ago: “Nothing exists except atoms and empty space; everything else is opinion.” ■



For Further Reading...

Like atoms and space, physics books are everywhere. Whether you buy or borrow, your book is likely to be checked out by a device that scans a bar code with a laser beam—a direct outgrowth of physics research. A list of the best (and many of the rest) is on page 8.

For Further Reading...

The Physicists: The History of a Scientific Community in Modern America	Daniel J. Kevles	Vivid saga of atomic weapons scientists and their postwar role. New preface details politics behind death of SSC.
The Second Creation: Makers of the Revolution in 20th Century Physics	Robert P. Crease and Charles C. Mannand	Particle physics told through two generations of physicists. Good history and good science, well-written and compelling.
The Physics of Baseball	Robert K. Adair	The great white particle. Lots of equations. Good field, no hit.
Blind Watchers of the Sky	Rocky Kolb	Fermilab astrophysicist tells highly engaging story of astronomy and astronomers.
Men Who Made a New Physics	Barbara Lovett Cline	Basic bio sketches of early particle physicists. Slim. Light on science.
Great Men of Physics: The Humanistic Element in Scientific Work	Emilio Segre, Joseph Kaplan, Leonard Schiff, Edward Teller	Renowned physicists offer insights into, respectively, Galileo; Faraday; Newton and Einstein; and Neils Bohr. Slim book, quick reading.
Taking the Quantum Leap: The New Physics for Non-Scientists	Fred Alan Wolf	Writing is bland, also on the stuffy side.
In Search of Schrodinger's Cat: Quantum Physics and Reality	John Gribbin	Solid beginning to the second tier of reading. Starts with basics but quickly moves beyond.
From Atoms to Quarks: An Introduction to the Strange World of Particle Physics	James S. Trefil	Lots of diagrams, lots of math laid out plain and simple. Another solid primer for the second tier.
In Search of the Big Bang: Quantum Physics and Cosmology	John Gribbin	Still a classic by the British astrophysicist.
A Brief History of Time	Stephen W. Hawking	A "must" for the second tier, when you're ready.
The Quark and the Jaguar: Adventures in the Simple and the Complex	Murray Gell-Mann	A step beyond, into abstraction and philosophy. Nobel winner Gell-Mann named the quark.
Achilles in the Quantum Universe	Richard Morris	Delightful musing on infinity as a driving force in physics and mathematics. Great examples.
The First Three Minutes: A Modern View of the Origin of the Universe	Steven Weinberg	THE classic popular work on the origin of the universe and the relationship between cosmology and particle physics.
Dreams of a Final Theory	Steven Weinberg	Literate consideration of the whys and hows of a single "theory of everything."
A Theory For Everything	Jeremy Bernstein	Essays by a noted physicist, from <i>The New Yorker</i> , <i>The Atlantic</i> , <i>Scientific American</i> , etc.
The Physics of Star Trek	Lawrence M. Krauss	What the series got right and wrong.
The Curve of Binding Energy	John McPhee	Noted journalist collaborates with bomb designer Ted Taylor to explore dangers of nuclear weapons proliferation.
"Surely You're Joking, Mr. Feynman!"	Richard P. Feynman	Farcical physicist commits gaffes, cracks safes, plays bongos, reveals headaches of Nobel Prize.
Genius: The Life and Science of Richard Feynman	James Gleick	Chronicle of contributions, from quantum electrodynamics to compelling testimony on the Challenger shuttle disaster.
Einstein: The Life and Times	Ronald W. Clark	The absent-minded violinist whom we may not know as well as we think we do.
<i>Scientific American Library</i> From Quarks to the Cosmos: Tools of Discovery	Leon M. Lederman and David N. Schramm	Clear illustrations highlight engaging, accessible explanation of methods used to explore the infinite and the infinitesimal.
<i>Scientific American Library</i> The Discovery of Subatomic Particles	Steven Weinberg	History of discoveries with appropriate physics introduced along the way. Well-illustrated with valuable appendix of physical principles.
<i>Scientific American Library</i> The Elusive Neutrino: A Subatomic Detective Story	Nickolas Solomey	University of Chicago physicist brings the particle search up to date. Well-written, with lots of photos and drawings.
<i>Scientific American Library</i> Powers of Ten: About the Relative Size of Things in the Universe	Philip and Phyllis Morrison, and the Office of Charles and Ray Eames	Excellent companion to any reading in physics: graphic illustrations of sizes in scientific notation.
Particles and Forces: At the Heart of the Matter	Richard A. Carrigan, Jr., and W. Peter Trower, Editors	Collection of <i>Scientific American</i> articles. For serious amateurs with firm grounding.