The Big Bang -- Mostly Smoke?
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THE SHADOWS OF CREATION

Dark Matter and the Structure of the Universe.
By Michael Riordan and David N. Schramm.
Illustrated. 277 pp. New York:
W. H. Freeman & Company. $18.95.

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IN 1974 David N. Schramm was part of a team of young up-and-coming astrophysicists who carefully inventoried the contents of the universe and concluded that it would continue to expand into infinity for all eternity. Astronomers have since noticed that spiral galaxies spin so rapidly that a reservoir of dark, unseen matter — up to 10 times more stuff than the luminous objects we see — must surround each galaxy to serve as a gravitational glue that keeps the spiraling disks from flying apart.

This dark matter could be composed of just ordinary matter, but in a form that is difficult to detect: possibly a host of failed stars, black holes or nuggets of quark matter. But the story gets more complicated. The most fashionable cosmological theories suggest that our universe may have begun not only with a bang but with a sort of cosmic burp, known as inflation — a brief instant when spacetime did more than expand; it tore outward like a science fiction spaceship on warp drive. In the process, the universe allegedly generated 100 times more dark matter than luminous material. That would provide enough gravitational muscle to bring our expanding universe to a screeching halt many eons from now.

Increasing the universe's mass 100-fold sounds like a lot, but it really isn't — only "about one hydrogen atom in every 10 cubic meters," note Michael Riordan, a particle physicist and assistant to the president of the Universities Research Association in Washington, and Mr. Schramm, a professor of physics at the University of Chicago. Yet cosmologists know that the Big Bang couldn't have cooked up even that much ordinary stuff. "If inflation is true," the authors write in "The Shadows of Creation," "the bulk of the dark matter is completely unlike normal, garden-variety matter made from quarks."

As the title of the book suggests, these more exotic particles would be "the shadows of creation," born in the fiery Big Bang but not yet seen. Theories of galaxy formation and the distribution of galaxies throughout the universe (which is coming to resemble a sink full of soapsuds) hinge on finding out whether all that extra matter truly surrounds us and, if so, what it is made of. Cosmologists will not rest until they solve this tantalizing puzzle.

Fans of Mr. Riordan's previous book, the splendid "Hunting of the Quark," might expect something similar — a gripping tale of the search for dark matter told through the experiences of the participants. But he and Mr. Schramm have chosen a far different approach. With its casual references to "cluster-cluster correlations," "adiabatic fluctuations" and "gauge bosons," this work is short on inside stories and long on technical details.

Actually, that is not meant to be a negative comment. Several good books on the dark-matter mystery — such as "The Dark Side of the Universe" by James Trefil and "The Dark Matter" by Wallace Tucker and Karen Tucker — have already been published for the lay audience. "The Shadows of Creation" is plainly intended for readers who are scientifically sophisticated, are intrigued by cosmology (the Hollywood of science) and want to forgo the journalistic appetizers and dig right into the scientific meat. The authors serve these readers reasonably well by providing a concise, encyclopedic review of the field and touching on all the topics currently grabbing the science news headlines.

The book is at its best when it talks about ideas in which Mr. Schramm was directly involved. For example, in the late 1970's he and two colleagues closely studied all the nuclear reactions possible in the early universe. Looking over the astrophysical evidence, they could only conclude that there were a limited number of particle types, building blocks of ordinary matter, with which to construct the visible cosmos. More than a decade passed before particle physicists could confirm that discovery on earth with their particle accelerators. It is fascinating to read how the physics of the macrocosm, the universe at large, can serve as such a powerful probe of the physics of the very small.

THESE limits on what makes up ordinary matter, however, do not rule out the existence of extraordinary matter. The National Science Foundation has taken this idea seriously enough to set up a Center for Particle Astrophysics at the University of California, Berkeley, in hopes of capturing an exotic dark-matter particle. If there is such a creature, finding it could be as momentous as the discoveries of the electron, proton and neutron, maybe more so. This dark matter, unlike the stuff that makes up people and planets, would be the predominant substance of the universe. "So strange is this dark matter," the authors write, "that it may be presumptuous to call it 'matter' at all. It is the aether of today."

The hottest candidates around, hypothetical particles such as photinos and gravitinos, arise in theories that are grounded in a strong belief that the laws of physics display certain symmetries. Will these grand unified theories turn out to be accurate? For medieval thinkers, holding on to the dogma that planetary orbits were perfect circles crippled the advancement of science. The sheer elegance of general relativity's equations, on the other hand, led Einstein to important insights into the nature of gravity. A love of beauty in physics presents both benefits and perils.

Observations and experiments, Mr. Riordan and Mr. Schramm rightly stress, will be the final arbiters. A solution to the dark-matter mystery may add just a few details to the model of the Big Bang and the story of the universe's evolution. But "The Shadows of Creation" helps us understand that an answer also has the potential to alter the entire tale. □

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