books

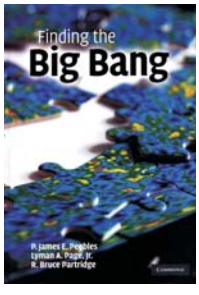
The cosmic microwave background in living color

Finding the Big Bang

P. James E. Peebles, Lyman A. Page Jr, and R. Bruce Partridge
Cambridge U. Press, New York, 2009. $80.00 (571 pp.). ISBN 978-0-521-51982-3

Reviewed by John C. Mather

A thrilling page-turner, *Finding the Big Bang* is the adventure story of one of modern science's great discoveries, the cosmic microwave background radiation from the early universe. The book is edited by three insiders: James Peebles, Lyman Page Jr, and Bruce Partridge. Peebles, the lead editor, has been at the center of the story for 45 years and is the author of some of the standard textbooks in cosmology, including *Principles of Physical Cosmology* (Princeton University Press, 1993). Lyman Page Jr is a major participant in NASA's mission to measure the CMBR with the *Wilkinson Microwave Anisotropy Probe*. Bruce Partridge has also participated in efforts to measure the CMBR and wrote *3K: The Cosmic Microwave Background Radiation* (Cambridge University Press, 1995). Peebles, Page, and Partridge were there, and they tell a good story.



The book starts with a coherent historical introduction that parses the matrix of original papers and reveals the key steps for predicting and measuring the CMBR. Following is the heart of the book—44 essays of more than 300 pages recalling CMBR work in the 1960s. The volume concludes with a look at CMBR physics from the 1970s to the present day. The introductory material could be used to teach basic cosmology to undergraduates. In addition to Peebles's *Principles of Physical Cosmology* I also like Steven Weinberg's *The First Three Minutes* (Basic Books, 1993), still a brilliant popular summary, and his self-contained *Cosmology* (Oxford University Press, 2008), which was reviewed in PHYSICS TODAY (June 2009, page 50).

The essays, which have a wonderful variety of biographical detail, reveal in living color the personalities, motivations, feelings, and scientific steps and missteps along the way.

One chapter by Paul Henry begins, "The last thing I remember from that day is Dusty Rhoads and Gene DeFreece depositing me at my motel room. . . . And at that point I passed out." How can one not keep on reading? And the chapter by Rainer Weiss includes, "Much as the free-fall was a rude introduction to the hazards of ballooning, it was also a gift to keep us from confirming an erroneous result."

Real revelations to me were the essays by Andrei Doroshkevich, Malcolm Longair, Igor Novikov, Yuri Smirnov, and Rashid Sunyaev. They all cite Yakov Zel'dovich as an incredible force whose constant personal attention and brilliant insights pushed his colleagues to greatness during those tough times in the Soviet Union of the 1960s. The final chapter summarizes progress since the 1960s. It is a deep and densely packed story of intense efforts to reach the now-standard ΛCDM (cold dark matter model with a cosmological constant) with well-measured parameters. The section could be used to introduce graduate students to modern cosmology.

Why didn't anybody measure the CMBR sooner? It looks easy now—Timo Stein, a bright German high-school student, has done it (*Sterne und Weltraum*, 13 June 2008). Joseph Weber told me that he wanted to do it in the late 1940s, but people told him it was impossible. Arno Penzias, in this book, explains what kept observers from trying to detect the CMBR before he and Robert Wilson discovered it in 1964. The work would have been difficult, and the time to payoff would have been long. Moreover, there were plenty of obviously important and much easier experiments for a scientist to do. Says Penzias, "First of all, there were no idle radio astronomers. The first few radio observatories were just being set up, and almost anything they did would break new ground—at least as long as the rudimentary equipment they used worked well enough to produce useful data." So, people didn't try to measure the CMBR in 1948, when George Gamow and Ralph Alpher predicted its existence and began their vain efforts to get others to detect it. It was tough to do even in the 1960s. In fact, some scientists, for various reasons, did not realize it was time to make a measurement. But at least some people were like me and followed Peebles's advice, quoted by Yu Jer-tsang: "Stop reading, start thinking."

Finding the Big Bang will be of interest to anyone who wants to know how scientific discoveries are really made. For me, reading the essays was like studying my family tree, and it was endlessly fascinating. For all of us, the answers to key questions in this area of cosmology—for example, How did we get here? Where are we going?—can now be discovered in this fine book.

John Mather is senior project scientist for the *James Webb Space Telescope* at NASA's Goddard Space Flight Center in Greenbelt, Maryland. He and George Smoot shared the 2006 Nobel Prize in Physics for their measurements of the cosmic microwave background radiation. Mather is coauthor with John Boslough of *The Very First Light: The True Inside Story of the Scientific Journey Back to the Dawn of the Universe* (Basic Books, 2008).

Complexity

A Guided Tour

Melanie Mitchell
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The notion of complexity is one of the most controversial and debated issues of scientific inquiry, and the chances are slim that the debate will be resolved anytime soon. Essentially, complexity is a collective noun for those uneasy feelings people have when faced with a system whose components and interactions are known but whose behavior adds up to more than the sum of its parts. But just what is it that makes us uncomfortable? Is it solely the system,

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