Detections from Space

3 K. The Cosmic Microwave Background Radiation. R. B. PARTRIDGE. Cambridge University Press, New York, 1995. xx, 373 pp., illus. $89.95 or £60. ISBN 0-521-35254-1. Cambridge Astrophysics, 25.

In 1964, a group of physicists at Princeton University began meeting regularly to plan an experiment that would detect radiation left over from the earliest moments of the Big Bang. Outlandish as this enterprise must have sounded to their colleagues, it was in fact long overdue. Alpher and Herman had predicted some 20 years before that this radiation is a testable feature of Gamow's Big Bang model. In retrospect it is curious that no one in the intervening 20 years detected the cosmic background radiation (CBR). Indeed, as Partridge details, it is not quite accurate to say that the CBR was not detected. Rather, the people who detected it during this time—and there were several—were not the same people who expected it and would have been able to identify it as "cosmic." Conversely, the cosmologists were notoriously unlucky in their attempt to understand the astronomical observations.

All such problems would undoubtedly be put to rest by the group assembled at Princeton: Dicke, Peebles, Roll, and Wilkinson understood clearly what it was they were looking for. Even more to the point, Dicke had worked in the Radiation Lab at MIT during World War II and had designed the type of instrument that was necessary to detect the CBR. As Partridge tells it, during one of their lunch meetings the group was interrupted by a telephone call. The other three heard only Dicke's side of the conversation. Most of the time Dicke was silent, occasionally repeating a phrase—"horn antenna" or "liquid He calibrator"—which was familiar to them because they were building just such instruments. When Dicke hung up, he said, "Well boys, we've been scooped."

And what a scoop it was! The call came from Arno Penzias, who, together with Robert Wilson, had been unsuccessful in attempts to get rid of the excess noise in their radio antenna. When the dust settled, it became clear that the cosmic background radiation had indeed been discovered, the Big Bang model became widely accepted, and Penzias and Wilson were awarded the Nobel Prize in 1979. (Given the history of near misses detailed by Partridge, it might have been appropriate to include Bernie Burke in the Nobel citation, since he was the one who informed Penzias and Wilson of the doings of the Princeton group and thus precipitated the fateful phone call.)

Perhaps the most important lesson to come out of the delayed discovery of the CBR is that it is extremely difficult to be well versed in both the theory and the observation of the CBR. This remains true today. Observers have to listen to theorists drone on about "the tightly coupled limit," "acoustic peaks," and "active vs. passive perturbations" while we theorists struggle to understand the differences between HEMTs and bolometers, calibration uncertainties, and side-lobe pickup.

Partridge's book goes a long way toward bridging the gap between these two groups of scientists. He successfully reduces radio astronomy to a chapter, picking out the pieces that are essential to the CBR. He then methodically goes through experiment after experiment, describing the techniques and instruments used to make the measurement and the sources of error that each group was faced with. None of this comes off as dry, for two reasons. First, there are many figures, which are invaluable to someone unfamiliar with the instruments. Second, Partridge has been an important participant in many of these experiments and does not hesitate to throw in his personal opinions and misgivings about the many experiments. These too are extremely valuable to someone who has not been there.

Ironically, the weakness of the book is related to its very importance and relevance. While the strides in the field from 1964 to the early 1990s were indeed impressive, it has since been recognized that anisotropies in the CBR contain even more information than anyone had realized. Particularly since the detection by the COBE satellite of these anisotropies in 1992, much progress has been made on both the theoretical and the observational fronts. For the most part, the book misses these latest developments. For example, the section on statistics focuses mainly on setting upper limits on signals. This was appropriate for the experiments before COBE. Since 1992, though, there have been dozens of detections; the focus has now shifted to techniques for analyzing them. With the MAP and COBRAS/SAMBA satellites due to be launched within the next ten years, the issue of analyzing very large data sets is also becoming essential.

After 30 years, the cosmic background radiation remains the most promising probe of the early universe. Over the next ten years, startling claims will emerge from the CBR community. Estimates of the Hubble constant, curvature of the universe, and

Vignettes: Communication Styles

Suppose we come across a robot trundling a shopping cart through a supermarket and periodically consulting a slip of paper with symbols written on it. One line is:

MLK@.5×GAL if P<2×QT/P else 2×MLK@QT

What, if anything, is this gibberish *about*? We ask the robot. It replies, "That's just to remind me to get a half gallon of milk, but only if the price of a half gallon is less than twice the price of a quart. Quarts are easier for me to carry."

—*Daniel C. Dennett*, in *Kinds of Minds: Toward an Understanding of Consciousness* (BasicBooks)

The typical spell-checker highlights all the words that are spelled wrong, and even those that *might* be wrong. The result? There is no praise, a great deal of criticism, and much of it unwarranted. . . .

Now consider a spell-checker that substitutes sugar for vinegar. At the end of the check you might read, "Your spelling was significantly above average. You should be commended for your work." Intermittently during the check, it also says, "You spelled this difficult word correctly." Even if the words were not particularly difficult, such unwarranted praise will often have a positive effect, especially if the phrasing changed each time the praise was introduced. . . .

No doubt praise can be over-done, but that threshold has yet to be reached in new interactive technologies.

—*Byron Reeves* and *Clifford Nass*, in *The Media Equation: How People Treat Computers, Televisions, and New Media as Real People and Places* (Cambridge University Press)

cosmological constant accurate to a few percent will be made. For both the people making these claims and those attempting to understand their validity, this book will be an essential resource.

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Molecular Aides

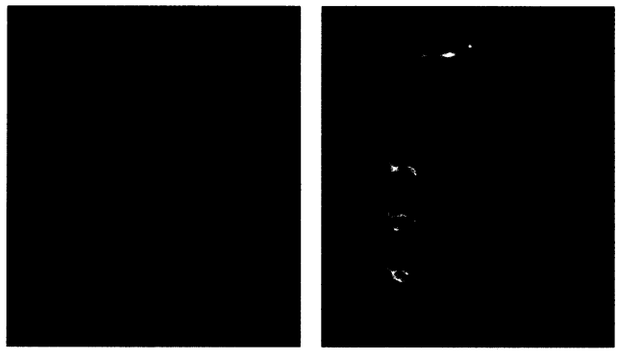
The Chaperonins. R. JOHN ELLIS, Ed. Academic Press, San Diego, 1996. xvi, 323 pp., illus., + plates. $79.95 or £59. ISBN 0-12-237455-X. Cell Biology.

The so-called protein-folding problem—that is, how proteins adopt and maintain their distinctive configurations or native state—remains one of the major unresolved questions of biology. The processes of protein folding are directly related to the pathology of such diseases as mad cow disease, amyloidosis, cystic fibrosis, and sickle cell anemia. Likewise, protein folding is of importance to biotechnology and the pharmaceutical industries, bearing as it does on the assessment of new biological protein targets, the creation of novel drugs, and the hoped-for ability to predict protein structures.

Research on protein folding was, until recently, primarily the province of biophysicists. However, observations over the past decade in molecular genetics, biochemistry, and cell biology have provided novel insights into a family of proteins, known collectively as molecular chaperones, whose functions are to assist in the processes of protein folding, assembly, translocation, and degradation. Indeed, molecular chaperones have been identified as important participants in numerous biochemical events involving the cell cycle and extracellular and intracellular signaling. The discovery of molecular chaperones does not belie the importance of intrinsic properties of proteins in guiding their folding to the native state. Indeed, it was recognized in the 1960s by Christian Anfinsen that "another large molecule . . . could influence the folding process by intermolecular reactions" that could catalyze these events or enhance the kinetics of protein folding.

The subject of *Chaperonins* is a single well-investigated group of the molecular chaperone family that falls into the subclasses GroE and TCP-1 chaperonins. The book has a thematic coherence lacking in more general books on molecular chaperones. Key facts and highlights are presented in a detailed and balanced fashion, the volume is well organized, and the chapters are clearly written and use a common nomenclature, a feature that should be appreciated by readers. Consequently, the volume is an excellent resource for both students and advanced researchers. Topics addressed range from the evolutionary relationships among chaperonins to their possible roles in infectious diseases.

Appropriately, the emphasis of the volume is on the biological and biochemical properties of chaperonins found in chloroplasts, photosynthetic bacteria, and mitochondria and on the regulation and function of chaperonins in *Escherichia coli*. The introduction provides a useful historical perspective on the discovery of chaperonins; we are reminded of the importance of serendipity in science and of the convergence of observations from genetics and biochemistry. Much of the current excitement is provided by in vitro studies of chaperonins in protein folding and biophysical studies on the unique structure of the chaperonin oligomer and its role in recognition and folding reactions. A conceptual understanding of the role of chaperonins in protein folding has been provided by electron microscopic and crystallographic images, which have revealed two seven-membered rings that associate with non-native proteins, leading, upon binding and hydrolysis of ATP and the co-chaperonin, to conformational changes in the chaperonin complex and the release of the substrate, often in a native state. The elegance of these images is tantalizing because they leave most essential phenomena visible but unexplained. We are left with the compelling picture of a macromolecular structure, a "protein-folding machine," that can be best described as a protein test tube or cage that provides the environment that facilitates the folding of an unfolded protein to its native state while restricting inappropriate inter- and intramolecular interactions, a function appropriate to the moniker chaperonin.



Electron microscope reconstruction of chaperonins. *Left*, GroEL-GroES toroid; *right*, cross-sectional view. [Helen Saibil]

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Browsings

Invention by Design. How Engineers Get from Thought to Thing. Henry Petroski. Harvard University Press, Cambridge, MA, 1996. xii, 242 pp., illus. $24.95 or £16.50. ISBN 0-674-46367-6.

Case studies of the paper clip, the pencil, aluminum cans, airplanes, high-rise buildings, bridges, and other "familiar objects."

A Field Guide to the Birds. Giving Field Marks of All Species Found in Eastern North America. ROGER TORY PETERSON. Commemorative edition. Houghton Mifflin, Boston, 1996. xxiv, 167 pp. + plates. $18.95. ISBN 0-395-85493-8.

A facsimile reproduction of the original 1934 edition of this "bird book on a new plan," whose author died in July 1996.

A Scientist Speaks Out. A Personal Perspective on Science, Society and Change. Glenn T. Seaborg. World Scientific, River Edge, NJ, 1996. xvi, 446 pp., illus. $48. ISBN 9810222041.

Texts of 39 lectures, 1955–1991, by the chemistry Nobelist and former chairman of the Atomic Energy Commission and University of California chancellor.

The Thermal Warriors. Strategies of Insect Survival. Bernd Heinrich. Harvard University Press, Cambridge, MA, 1996. xvi, 221 pp., illus., + plates. $27 or £17.95. ISBN 0-674-88340-3.

An informal "primer" on the regulation of insect body temperature by the author of *Bumblebee Economics* and *The Hot-Blooded Insects*.

The Ultimate Resource 2. JULIAN L. SIMON. Princeton University Press, Princeton, NJ, 1966. xliv, 734 pp., illus. $35 or £27.50. ISBN 0-691-04269-1.

An updated and much expanded edition of a 1981 work by an author well known for his vigorous criticism of environmentalist and demographic "doomsayers"; in his view the "ultimate resource" is "skilled, spirited, and hopeful people" who will find ways of meeting the challenges others worry about.