Glittering prizes

Joseph Silk

A Hundred Billion Stars.
By Mario Rigutti. Translated by Mirella Giacconi.
MIT Press: 1984. Pp. 285. $25, £26.15.

TO ALL Earth-bound observers, stars are brilliant points of light, unresolved even by our largest telescopes; poets and astronomers alike must work with similar raw material. Imagination aids the poet in conjuring up alien vistas, while the astronomer is assisted by sophisticated devices that split the light into a thousand frequencies, unravelling the most intimate nature of the stellar matter. It is a rare astronomer who is capable of clearly communicating his esoteric discoveries, his knowledge of what really constitutes a star, to the uninitiated audience; and, more, of enthralling his readers, who are too frequently abused by sycophantic disciples of pseudo-science.

In *One Hundred Billion Stars,* Mario Rigutti has escaped from the dreary level of popular science writing that permeates the pages of numerous magazines. He does not give us breathless prose, studded with superlatives, yet manages to transmit a genuine awe for the starry heavens. Professor Rigutti's style is chatty and informal. He writes as though he were telling a bedtime story to a child, and succeeds in captivating people of all ages. He takes occasional potshots outside the world of astronomy, rightly believing that practising scientists cannot ignore social and political issues. His unassuming approach and his evident sincerity provide a refreshing perspective on the world of the stars. Due credit should go to the translator, Mirella Giacconi, who appears to have ably succeeded in capturing the spirit of the original Italian text.

The book commences with a discussion of the Sun, a logical place to begin. It continues with the inner planets, and then comes the major section, on our galaxy. Most of what is known about our galaxy is told, not too much progress having been made in stellar evolution since 1978 when the Italian edition appeared. The new discoveries have certainly not changed our overall view of our local celestial environment, and the book does not suffer too adversely from this shortcoming. The author rightly concentrates on capturing the essence of the underlying truth behind those glittering points of light in the sky, and, by and large, he succeeds. □

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Pi in the sky

John D. Barrow

Constructing the Universe.
By David Layzer.
Scientific American Library: 1984. Pp.313. $21.95, £15.95. (Members of the Library only.)
Stephen Hawking's Universe.
By John Boslough.
William Morrow: 1984. Pp.158. $12.95.

DAVID Layzer's addition to the Scientific American Library is extremely ambitious. It aims to tell the story of cosmological reasoning from the pre-Socratics to the present day. Not that it is just a history book: the author's approach is distinguished by his inclusion of accounts of the mathematical reasoning used by the past masters in their classic investigations. In this way one is able to see the actual logic of scientific development, a far better approach than the stream-lined résumé which uses modern concepts to tidy things up retrospectively. Layzer also enlivens the story by commenting on the discussion and dissent that surrounded the introduction of new concepts; for example, Berkeley's attitude to "fluxions". These early chapters dealing with historical developments are carefully written, beautifully illustrated and well-integrated into a discussion of the scientific method which runs through the text.

The next part of the book provides a well devised description of special relativity and a brief survey of the key concepts involved in the formulation, verification and application of general relativity. With all this groundwork laid out so thoroughly I expected to find as its climax a superb final portion of the book devoted to modern cosmology. I was disappointed.

The author makes much of the importance of correctly formulating the Cosmological Principle but then does so in a misleading and unappealing way by defining it to mean that "the universe itself has the same spatial symmetries as the laws that govern its structure and evolution". This statement is said to be "axiomatic", which is unfortunate, since it is clearly false. Furthermore, the claim that any statistical formulation of the Cosmological Principle must be rejected because it implies preferred places is also illogical. We can only make scientific statements about the observable portion of the Universe and there may well exist "preferred" places where observers are most likely to be found. The "many-bubble" inflationary universe models considered recently need not satisfy any "axiomatic" cosmological principle.

However, my main worry about the book arises from the author's cursory, and to my mind, dishonest treatment of the observational evidence for the hot big bang model — a topic which ought to have been extensively and fairly discussed in a book such as this. The author displays "predictions" of the cosmic abundances of helium and deuterium from the hot big bang model supposedly made in 1965 and 1984, along with the "observations" of these abundances at those same dates. Virtually all the information provided is incorrect. The presently observed cosmic helium mass fraction does not lie in the range 10–21% as claimed, nor did it lie in the range 26–28% in 1965. As far as I am aware, there were no big bang deuterium predictions in 1965, nor were there any extraterrestrial measurements. Nor are the predictions any different, in principle, over this time span; they are only made to look very different by the author's assumption that the present baryon density must be ten times higher than we believed in 1965 because of the flat rotation curves of spiral galaxies. But if the dark matter responsible for that state of affairs is non-baryonic, it does not deplete the deuterium abundance in the way Layzer claims. Further, quite a lot of significance is attributed to the Woody–Richards measurement of a distortion in the microwave background even though its statistical significance has since been downgraded.

Having presented this brief caricature of the hot big bang model, the author then devotes 22 pages to detailed exposition of his own speculative ideas developed in a student's thesis in 1973. These ideas regarding a non-primordial origin of the background radiation are interesting, but I think that they are given misleading and misplaced prominence in a book of this nature; after writing with unusual care and clarity for three-quarters of the way, it seems to me that Layzer has over-indulged himself. As a volume in the Scientific American Library series, a large number of people will read this book. It is a pity that having done so, they will know nothing of the exciting observations and theories that underpin our most recent ideas about the construction of the Universe. This is a book that could have been outstanding — what a sadly wasted educational opportunity.

It is difficult to know what to say about John Boslough's "biography" of Stephen Hawking, written, I gather, without its distinguished subject's blessing. Certainly, it is written in a style reminiscent of certain dubious tabloid newspapers. The book is built around a collection of quotes and anecdotes gleaned at first- and second-hand from sporadic conversations and interviews, but like many pieces of semi-sensational journalism the author is interested only in the extraordinary and the remarkable. This approach may work well when reporting the Cup Final but in any work of biography it is disastrous. Here, the real picture of Hawking's character and ideas is superseded by a patch-work of aphorisms and anecdotes that are atypical, for indeed that is why they are so memorable. Why has the author not interviewed Hawking's many collaborators and associates with the goal of presenting an accessible but thorough and accurate description of his way of thinking? Accessible need not mean trivial.

The author's handling of the scientific ideas involved is unreliable and I am sure, to anyone not completely familiar with what he is trying to explain, unintelligible. Buzz-words and acronyms spontaneously appear without explanation — "GUT's", "flatness", "inflation", "Guth's scenario" — while the melodramatic style leads to errors and absurdities: Einstein's special relativity paper was not a "bombshell"; he did not show that "time did not always flow from past to present"; the concept of a black hole horizon did not arise as a consequence of Hawking's Area theorem, nor is its surface area the only externally observable property of a black hole. Then there is the description of how Einstein discovered the mass–energy formula: "Einstein came to the conclusion that $m = E/c^2$. From there it was just a simple algebraic step to the most famous equation in history, $E = mc^2$".

Perhaps some will enjoy this book. I didn't. Stephen Hawking *is* one of the world's most remarkable scientists and I hope that a biography worthy of his achievements will one day be written. This, I am afraid, is not it. □

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The best lab in the world?

Nevill Mott

Three Degrees Above Zero: Bell Labs in the Information Age.
By Jeremy Bernstein.
Charles Scribner's Sons: 1984. Pp.241. $17.95.

BELL Laboratories are envied worldwide, and Bell scientists know it. Of what other industrial laboratory could the vice-president for research write:

> . . . if I hire the fifth-best theoretical physicist in the country I can get away with it, but if I hire the fifteenth-best I am wasting my time. We are looking for number two or three, and we want to compete with the best universities for number one.

One can sometimes notice at conferences that the Bell scientists sit and talk together, and those from other laboratories sit elsewhere. What other industrial laboratory has had seven Nobel Laureates since the War? And certainly no other laboratory has been funded by the company (AT&T) with a monopoly of telecommunications in the United States.

Jeremy Bernstein's book gives a picture of Bell Labs by describing certain projects and some men and one woman at the centre of its achievements. It is written, too, at a moment when the future is in doubt, and uneasiness about the coming years colours many of the articles in it. Just two years ago an agreement was signed between the Justice Department and AT&T which split up the telephone company but allowed it to retain Bell Labs. Fears are expressed that fundamental research may be squeezed, results expected too quickly, supervision become too close and that Bell Labs will become "like any other industrial laboratory". Some of the scientists who feature in the book are optimistic but the anxiety comes through only too clearly. Those who have watched events from across the Atlantic have wondered whether it was worth while, so as to introduce more competition, to put at risk the quality of, perhaps, the best laboratory in the world.

I do not know whether Bernstein wrote this book because of what had happened to the telephone company; he does not say so, and it is not his main theme, though perhaps the most pertinent one. His aim is to tell a story. He writes of the early days of the laboratory, and then, inevitably, about the transistor.

This story has been told elsewhere, for instance in Braun and MacDonald's *Revolution in Miniature*, published by Cambridge University Press in 1978, and the author acknowledges what a fine study that book is. Reading Bernstein's own account, it seems certain that no organization but Bell could have made the breakthrough, at any rate not until years later. Even before the War, the need to replace the vacuum tube was recognized. The achievement, through the understanding of theory coupled with the most practical advances in materials science, could have occurred only in a place where the need was urgent and where all these skills existed. Even so, it was slow to come to fruition. The discovery was in 1947; it was the end of the 1950s before the electronic revolution was really underway.

Perhaps the most interesting pieces in the book are the vignettes of some of the people active now. The book had its origin in a discussion between the author and Philip W. Anderson, who shared the Nobel prize in 1977 with his former teacher J.H. Van Vleck and the present reviewer. An outstanding paper of Anderson's, which started the applications of solid state theory to electronics in glasses, was called "Absence of Diffusion in Certain Random Lattices", published in the *Physical Review* in 1958, and is referred to in the book's "Selected Bibliography". As the book is meant for non-specialists and indeed for readers who are not scientists at all, I should warn them that even for experts this is an exceptionally difficult paper; Anderson himself said it was "often quoted but never read". Its results were frequently disbelieved, but once accepted it was extraordinarily illuminating and, with a time delay of nearly ten years, sparked off a burst of theoretical work on non-crystalline semiconductors. Of course this work continues with great vigour at present.

Of interest too is the sketch of Anderson's career. It is surprising how hard it was for a theorist of genius, graduating from Harvard, to find a job in the immediate post-War years. But it was to Bell Labs he wanted to go, and he succeeded. Now, at sixty, he is something of an *éminence grise*, with a chair at Princeton and a role as adviser to the directorate of Bell. He has immense influence in American physics.

The woman in the story is Suzanne Nagel, described in 1970 when she joined the laboratory as "a very attractive, 27-year old, auburn haired Ph.D". Now she is one of many concerned with the glass fibre business. Of her current work, she told the author:

> I have been especially concerned with wringing the last drops of water from the fibers. Very small amounts of water — parts per billion — can cause attenuation of light in the spectral region where the lasers are emitting... Recently, by the way, we transmitted light for a hundred kilometers without the need for reamplification... The first transatlantic cable is due in 1988.

The title of the book refers to the temperature of the radiation background in outer space — the remains, so it is believed, of the energy dissipated in the Big Bang with which the Universe began 12×10^9 to 15×10^9 years ago. In fact the discovery of