

Bookshelf

subsequently cooked in supernovae. As accreting stars become large enough to be crushed by their own gravity, new thermonuclear production lines open up as the internal temperature increases. Eventually the contracting star is blown apart by its core pressure, and its contents whirl around the supernova remnants, buffeted by mighty shock waves, before finally being flung out into space.

Taking a close look at results from extensive air showers, Tolya Erlykin of Moscow's Lebedev Institute and Arnold Wolfendale of Durham, UK, see structure around the knee region, with slightly increased production in two nuclear bands, corresponding to oxygen and iron. These nuclei are the characteristic aroma of supernova cooking.

Looking at the acceleration of charged particles by supernova remnants, Erlykin and Wolfendale suggest that these tiny bumps in the cosmic ray yield are the fingerprint of a single nearby supernova whose particles were flung into space as the echoes of a mighty shock wave. Identifying which supernova is extremely difficult, as cosmic particles get tangled up in convoluted intergalactic magnetic fields and are condemned to follow tortuous paths.

As well as explaining aspects of cosmic rays, these results also open a new window on nuclear reactions in the energy region around 10^{16} eV, where iron predominates.

As well as holding the prestigious Ambrose Swasey Chair of Physics at Case Western Reserve University, Cleveland, Ohio, Lawrence Krauss is also author of several famous popular science books, including the best-selling 'The Physics of Star Trek'.

Krauss word puzzle

A recent visitor to CERN's Theory Division was distinguished scientist and best-selling author Lawrence Krauss, who has three claims to fame. Look up the name in the learned literature and one quickly understands why the 43-year old theorist holds the prestigious Ambrose Swasey Chair of Physics at Case Western Reserve University, Cleveland, Ohio. But the name is also prominently listed in literary catalogues as author of several famous popular science books*. His 'The Physics of Star Trek', drawing on the divergence between compelling science fiction and less easily assimilated science fact, has consistently appeared in best-selling lists since its launch in 1995 and has since appeared in 11 other language versions. A sequel 'Beyond Star Trek' will appear later this year.

Each of these claims to fame are



impressive in their own right, but the third claim - being able to handle two such apparently distinct and demanding career paths at the same time - is perhaps the most impressive, if only for the demands on his time. Being a best-selling author also brings a continual demand for public appearances.

While many physicists encounter difficulties in writing popular accounts of their work, Krauss points to many counter-examples - Gamov, Jeans, Einstein,... - where scientists more eminent than most have contributed to contemporary culture without abandoning their scientific missions. He himself admits to having been particularly influenced by Steven Weinberg's book 'The First Three Minutes' (Basic Books, New York, 1977). As well as selling many copies, this milestone in scientific literature underlined the role of particle physics in the evolution of the Universe in the immediate aftermath of the Big Bang. Krauss set out to do just that with his first book, 'The Fifth Essence', about the enigma of dark matter, possibly the ultimately Copernican revolution.

Krauss writes quickly and well, usually at night, and his approach has become more popular with time. This writing ability must be ultimately genetic in origin, but he modestly attributes it at least in part to having studied history ('where I learned how to write'). His first commission was for the book which would ultimately become 'Fear of Physics', but he put this aside to write 'Essence' first. However he points out that explaining a difficult concept for a wide audience can be just as much of a challenge as cracking an esoteric research problem.

Rather than being overwhelmed by having two apparently conflicting pursuits, Krauss claims that his

writing can help focus his physics research ideas, and vice versa. 'It helps productivity,' he claims, explaining that he can be totally involved in both a book project and research at the same time.

He has always been interested in communicating ideas, and says that in putting his arguments across he feels his strongest duty is to be 'honest and accurate', with minimal fudging of difficult notions to make them easier to assimilate. Hence his critique of the Star Trek fables. However his view of Star Trek is not entirely tongue-in-cheek and he is aware that conventional scientific discipline must be tempered with imagination. As he says in 'Trek' - 'What does modern science allow us to imagine about our possible future as a civilization?' The result is that he maintains good relations with his scientific peers, remaining faithful to physics and avoiding unbridled pandering to popular taste that can

be a recipe for intellectual exile. As well as being a popular book, 'Trek' is used by physics teachers to help motivate their students.

On the physics side, Krauss' continuing multiple interests are in the direction of cosmology and astrophysics, but he points out that physics is not an excuse to generate abstruse formalism. Physicists, even when speculating about the ultimate mysteries of the Universe, still have to keep their feet on the ground. However quantifying cosmology is not easy, and his research goal is to open up new fundamental directions, and perhaps even to find a way of detecting the ever-elusive cosmic neutrino background.

The Inflationary Universe, by Alan H. Guth, published by Addison Wesley, reviewed by Lawrence M. Krauss

The breadth of this book represents both its success and weakness. Physicists will probably enjoy Guth's style - the logical framework, the meticulous attention to detail, and generous referencing. No idea is introduced until the proper background has been provided. However, I expect that some lay readers may find the details at times overwhelming, and may need to skim over some of the 300 or so pages of text, figures and charts - including three appendices and a glossary - on first reading. (I don't know how much readers will get out of the complete table of low mass baryons and mesons, for example.)

Those wishing to find out exactly what the inflationary universe idea is will have to first read almost 200 pages into the book - a wait which may prove frustrating for general readers (it was for the one reader I polled), although in the end, of course, the effort is worthwhile. While I believe the book could have been more heavily edited, the result is a comprehensive and personal view of a pivotal subject. And as Alan Lightman states in his otherwise uninspired foreword, many other books have appeared discussing Inflation in some detail (I count one of my own among the list), but only one can be written by Alan Guth.

Indeed, over 15 years since Inflation was unveiled, one might wonder what there is left to say. However, one gets in this book not only a grander and more careful introduction to the subject than is generally available, but one also gets a chance to witness the personal story behind it.

While the explanations are meticulous and clear, the book's uniqueness stems in part from Guth's own brand of humanity. Genuinely self effacing, often in awe of his more

The Lawrence Krauss Library

The Fifth Essence: The Search for Dark Matter in the Universe (US, Basic Books, 1989, UK Vintage Books);

Fear of Physics: A Guide for the Perplexed (US, Basic Books 1993, UK Jonathan Cape);

The Physics of Star Trek (US, Basic Books 1995, UK Harper Collins);

Beyond Star Trek (to be published by Harper Collins later this year).

Alan Guth is a crystal clear thinker and writer, and it shows in this book. As a young, terminal-track postdoc, in 1979 he entered the field of cosmology from the fringes and managed to change it forever. This book is in one sense a history of his own cosmic voyage from formal field theorist to father of our modern picture of the early universe.

In the process, however, it provides an expansive account of the evolution of modern cosmology and particle theory through its great successes of the 1970s, including the development of Grand Unified Theories (GUTs) - the foundation stone on which Inflation was built. The book ends with discussions of speculative current notions such as wormholes and the creation of universes from nothing.

senior famous colleagues, Guth has written an honest book. Having known him, first when I was a graduate student and then as a postdoc, following his arrival at his first tenure track appointment at MIT in 1981, and having been present during many of the developments discussed in the second half of this book, it is refreshing to see a personal history written so objectively. Guth is a compulsive diarist. While many people write from the vantage point of dim memory, Guth has had the benefit of detailed documented diaries and notes to help affirm his comments.

There are also a few interesting revelations - in particular involving the events surrounding the famous 1982 Nuffield Workshop at Cambridge when the discovery that Inflation could explain the origin of primordial structures was made.

Most of the book is devoted to a pedagogical treatment of modern cosmology and particle theory, presenting a clear history of the subject. Moments which display Guth's warmth and humour do arise - my favourite instance is a scholarly footnote argument why a more proper acronym for Grand Unified Theories (conventionally GUTs) should be GUTHs!

An informative and enjoyable read, its immediate impact may have been greater had it appeared 10 years earlier, or perhaps been packed with a little less detail even now, but I expect this will be a good resource not only for physicists wanting to learn more about early universe cosmology, but also for graduate students, interested undergrads and motivated members of the general public who want to understand the excitement generated in cosmology over the past 20 years.

*Particle Detectors by Claus Grupen:
Cambridge University Press
ISBN 0-521-55216-8*

Fifth in the Cambridge Monographs series on Particle Physics, Nuclear Physics and Cosmology, this book will make a useful addition to any experimental physicist's armoury. Professor Grupen's career has taken him from cosmic ray muons in the 1970s to CERN's ALEPH experiment today, and in writing the book nothing has been left out.

The first chapters cover essential physics, beginning with an overview of particle interactions with matter followed by a discussion of detector performance and radiation units. Detectors for track measurement are the first to be covered in a chapter which concentrates on gas-filled devices. Bubble chambers and emulsions are also discussed. The author points out that a particular type of detector does not make only one type of measurement, and chooses to leave solid state devices until later in the book. Subsequent chapters cover time measurement, particle identification, energy and momentum measurement, electronics, data analysis, and simulation. Each chapter ends with a comparative summary of different approaches; valuable information to anyone with a detector to build.

A final chapter on applications gives an impression of how varied the use of particle detectors has become. Applications from particle physics to 'x-raying' the pyramids with cosmic ray muons are discussed.

In summing up, Grupen justifies his coverage of apparently obsolete detectors, pointing to the recent development of holographic readout of vertex bubble chambers as an

example of how new life can be breathed into old technology. Inevitably in such a fast moving field, much changes in the time it takes to write a book. The author himself admits that his book can be just a snapshot, but if this is the case then Professor Grupen has chosen a very fine grained emulsion for his work.

James Gillies

Flash of the Cathode Rays - A History of J.J. Thomson's electron, by Per F. Dahl, IOP Publishing, ISBN 0 7503 0453 7, £29.50/\$49.50

Per Dahl of Berkeley, an expert on superconducting magnets and son of the legendary Odd Dahl, who initially headed the project to build CERN's synchrotron, has produced a fascinating account of the twists and turns of particle physics prehistory. Leaving no archival stone unturned, his scholarly book covers the early history of atomic structure, carefully tracing the emergence of the particulate theory of electricity, through the discovery of the electron a hundred years ago, to Rutherford's revelation of the nuclear picture in 1911. The result is a valuable source of historical authority and wisdom. His diligence is underlined by almost a hundred pages of notes and fifteen pages of 'select' bibliography.