

BOOKSHELF

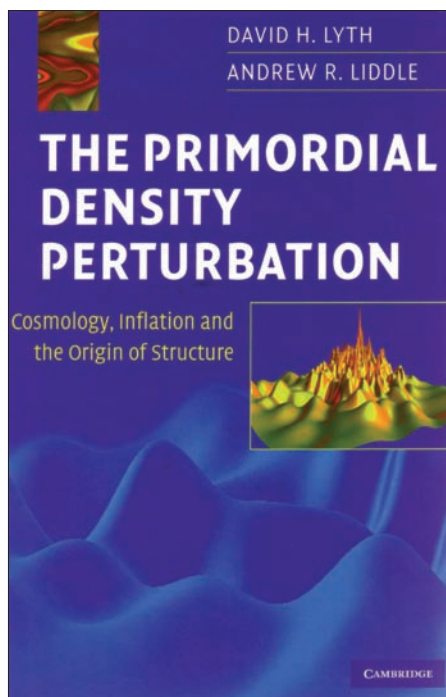
The Primordial Density Perturbation: Cosmology, Inflation and the Origin of Structure

by David Lyth and Andrew Liddle, Cambridge University Press. Hardback ISBN 9780521828499, £40 (\$75). E-book ISBN 9780511536922, \$60.

In the early 1990s, the discovery of minute inhomogeneities in the temperature of the cosmic microwave background (CMB) marked the beginning of an observational endeavour that continues today thanks to dedicated satellite missions, such as the Wilkinson Microwave Anisotropy Probe and Planck. Current observations seem to suggest that the CMB anisotropies and polarization stem from inhomogeneities of the spatial curvature, which are related via general relativity to the fluctuations of the energy density. The latter fluctuations are often called, in the jargon, density perturbations. This monograph by David Lyth and Andrew Liddle unveils the different facets of the interplay between density inhomogeneities, quantum field theory and observational astrophysics. It follows (and partly overlaps with) *Cosmological Inflation and Large-Scale Structure*, written less than nine years ago by the same pair of authors.

The Primordial Density Perturbation is organized into three parts. The first and second parts provide a swift reminder of concepts connected to relativity (both special and general) and the Standard Cosmological paradigm (sometimes dubbed the Λ CDM model where Λ stands for the dark-energy component and CDM is the acronym for cold dark matter). The third part of the book, titled “Field Theory”, collects all of those aspects of quantum-field theory that are germane to the evolution and normalization of cosmological perturbations. The section’s main focus is organized around the description of space-time geometry in its most relativistic regime, i.e. when the typical wavelengths of the fluctuations in the spatial curvature are comparable with the Hubble radius, whose size is a million times larger than the extension of a typical spiral galaxy, such as the Milky Way.

Despite the excellent effort made by the authors, it seems necessary – especially for students and novices – to keep other dedicated books about quantum field theory on hand as well as books about cosmology (appropriately quoted through the 29 chapters of the text), such as the



monumental *Cosmology* by Steven Weinberg (Oxford University Press 2008, *CERN Courier* May 2009 p43) and the reference treatise of the early 1990s *Principles of Physical Cosmology* by Jim Peebles (Princeton University Press 1993).

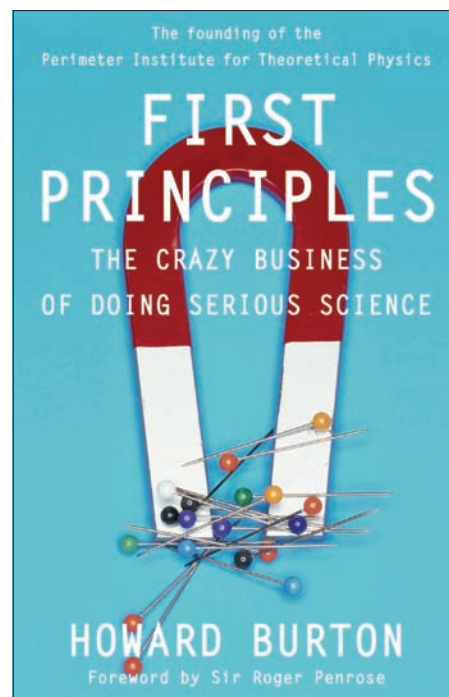
The rich literature that is flourishing these days on the mutual interplay between the microphysics probed by particle accelerators and the macrophysics scrutinized by astrophysics and cosmology suggests an increasing interest in these themes among a community that ranges from undergraduate students to skilled practitioners of the field. The different treatises are in agreement on one aspect: the unknown territory to be charted by the LHC will influence not only the forthcoming path of particle physics but also the development of cosmology and high-energy astrophysics during the next two decades.

Massimo Giovannini, CERN and INFN (Milan-Bicocca).

First Principles, The Crazy Business of Doing Serious Science

by Howard Burton, Key Porter Books. Paperback ISBN 9781554701759, \$24.95.

Science, usually an also-ran in the major funding stakes, is nevertheless occasionally surprised by generous benefactors. Just before the Wall Street crash in 1929, the



Bloomer family sold their department store to Macy’s of New York and altruistically invested the proceeds in what would become the Institute for Advanced Study (IAS), Princeton. This was not to be a university, and its research would not be dictated or contracted. With mathematical science high on its agenda, early members included Albert Einstein, John von Neumann and Kurt Gödel.

The IAS soon became a template for other research centres, both in the US and abroad. One of these was Israel’s Weizmann Institute, whose initial benefactors were the Sieff family, from another retailer, Britain’s Marks and Spencer. Another was India’s Tata Institute, supported by the mighty eponymous industrial combine. More recently came the foundation established by the Norwegian-American innovator Fred Kavli.

Another fresh venture is the Perimeter Institute (PI) for Theoretical Physics in Waterloo, Ontario, established in 1999 by Mike Lazaridis, co-founder of Research in Motion, the developers of the ubiquitous BlackBerry handsets. Lazaridis thrust an unsuspecting Howard Burton into the role of PI’s first executive director, with the job of getting the new institute up and running. This book is Burton’s memoirs of those heady days.

After labouring towards a PhD in theoretical physics, and with financial

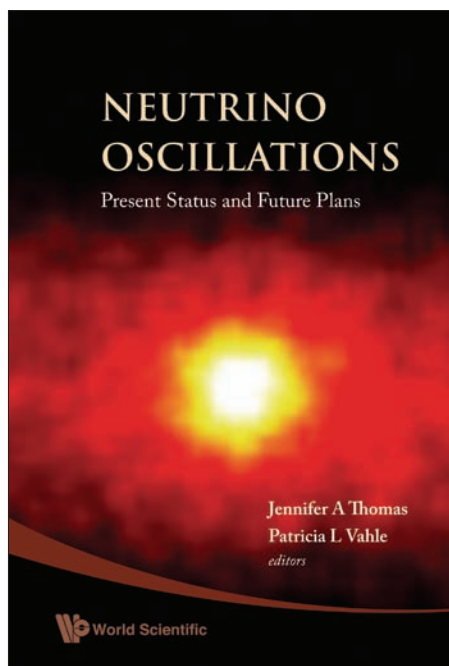
organizations snapping up numerate scientists, in 1999 Burton started looking for a job. The covering letter for his CV concluded with the line: "Please help save me from a lucrative career on Wall Street." One CV went to Research in Motion. To Burton's surprise a prompt and enthusiastic reply came from Lazaridis, who had an idea at the back of his mind and was looking for help to make it crystallize. Burton vividly conveys the difficulties of trying to sound enthusiastic in an interview for a job he didn't even begin to understand.

Nevertheless, he was hired. To clarify his own ideas, he went far and wide to explore possibilities and seek out recruits. One early candidate was Roger Penrose at Oxford, whose foreword to the book is characteristically stimulating and enigmatic by turns. There is a hilarious anecdote about trying to make a telephone call from Penrose's office. Another amusing episode comes when Burton goes to ask his former teacher at Guelph University to join the board of the new institute. On arrival, Burton is wrong-footed by being offered a postdoc position, which he immediately has to turn down and instead make his counter-offer to an even more surprised former teacher.

Soon, Burton was seeking other recruits and looking for suitable premises. With the first physicists in residence, attention turned towards establishing a working environment. Burton's initial confusion was now inherited by scientists unused to Lazaridis' work style. Burton's chapter, "The trouble with physicists", illustrates the culture shock when the brash commercial world meets the passive serenity of academia. Commendably, outreach was soon identified as a major objective at PI, with a successful series of public lectures and other events.

The book's "crazy" subtitle and the offbeat cover illustration could be misleading: at first glance it is easy to assume that the book is eccentric. However, its informal style masks serious issues. PI aims to redress the balance in a world dominated – culturally, intellectually, technologically and economically – by scientific research, but which is nevertheless largely uncaring and unappreciative of the importance of science.

Because PI is an institute for theoretical physics, theorists especially will enjoy the book, and many well known figures flit across the pages. There is no official collective



noun for theoretical physicists, but Burton's acknowledgements include a list of about 200 of them, which surely qualifies for one ("galaxy", "group", "resonance"?). *Gordon Fraser is editor of The New Physics for the 21st Century, recently reissued by Cambridge University Press in paperback.*

Neutrino Oscillations. Present Status and Future Plans by Jennifer A Thomas and Patricia L Vahle (eds.), World Scientific. Hardback ISBN 9789812771964, £40 (\$69). E-book ISBN 9789812771971, \$90.

This book is a collection of review articles related to neutrino oscillations. There is an introductory article presenting most of the basic theory, which is followed by seven articles about past or running experiments and concluded by five articles on future neutrino experiments (that is, at the time of writing; OPERA is now taking data). Each experimental article is written by a member of the respective collaboration. Somewhat pressed for time (and by the editor of *CERN Courier*) I thought I could "wing" this review by just reading the first article as well as two experimental chapters. However, I soon found myself engrossed in the book and hopped around from article to article, following my curiosity. This was quite enjoyable and also very informative.

The book is pleasantly concise at 265 pages and yet very accessible. It thus offers a

good overview of the current status of the experimental field. It was naturally necessary that a choice be made of which experiments to discuss. Thus, famous experiments such as the Homestake chlorine experiment as well as GALLEX and SAGE are only mentioned in the preface. The editors' goal is clearly not to compile a comprehensive coverage of the history but instead the main points on which our experimental understanding of neutrino oscillations rests today. Consequently the tritium experiments on neutrino mass are not discussed at all. However, some room is given to the unresolved questions regarding the LSND and MiniBooNE experiments. There is also no discussion of the wide-ranging theoretical models.

The editors make no statement as to the intended readership; I would think this is for active particle physicists. Younger graduate students might get a feel for the subject but would need to look up many of the original references or consult a textbook for an understanding of the arguments. In this context, it would have been helpful if the experimental chapters had explicitly referenced the relevant formulae of the theory chapter. Fortunately the book does contain an index to guide the reader. *Herbert Dreiner, University of Bonn.*

Strong Interactions of Hadrons at High Energies. Gribov Lectures on Theoretical Physics by Vladimir Gribov, prepared by Y Dokshitzer and J Nyiri, Cambridge University Press. Hardback ISBN 9780521856096, £80 (\$144). E-book ISBN 9780511451454, \$128.

This is a peculiar book in that it was published in 2009 but collects together the lectures on strong interaction theory that Vladimir Gribov gave in the 1970s – as rescued by Y Dokshitzer and J Nyiri from the written notes of some of the best of Gribov's students.

As the book explicitly declares and is evident from the content, the material has not been "modernized". It thus essentially presents the strong interactions before QCD, which is only marginally mentioned in the book (the last chapter barely touches it). Even within this restricted realm, some important "old" topics, such as broken chiral invariance and soft pion physics, are not discussed. (Perhaps the qualification in the title "at high energies" is meant to justify this omission).

What the book does treat in detail is the

S matrix approach, unitarity, analyticity and dispersion relations. It covers Regge theory in depth, starting from the basic non-relativistic theory up to Reggeon exchange and Reggeon field theory. This part is still interesting in that the precise relationship with QCD has not yet been derived, and the presentation is lucid and brilliant.

In conclusion the book is a tribute to the late Vladimir Gribov and provides the reader with the possibility of gaining an insight into his personal style and profound knowledge of the subject. However, the book does not offer a modern perspective on the current theory of the strong interactions.

Guido Altarelli, CERN.

Introduction to Modern Physics:

Theoretical Foundations by John Dirk Walecka, World Scientific. Hardback ISBN 9789812812247, £54 (\$93). Paperback ISBN 9789812812254, £40 (\$69).

Like other books by John Dirk Walecka, this introduction to modern physics is a well written textbook. A first glance of the table of contents is impressive: each chapter covers subjects that could correspond to a full course. The first chapter, a summary of Newton's mechanics, statistical physics and electrodynamics, is followed by an overview of the problems that, at the end of the 19th century, motivated the formulation of quantum mechanics (chapter 4) and special relativity (chapter 8). Chapters 5–7 cover atomic and subatomic physics, while the base for high-energy physics is introduced in chapters 9 (relativistic quantum mechanics) and 12 (quantum fields). Chapter 10 is about general relativity and chapter 11 covers quantum fluids and superconductivity.

Although making some cuts is unavoidable, the author has been able to provide an almost full overview of all of the fundamentals while avoiding the risk of making only a qualitative introduction. He introduces the basic mathematical tools necessary to make the text as quantitative as possible for the typical student undertaking such a course on modern physics. To keep the size and complexity of the treatment under control, Walecka decided to delegate part of the theoretical developments to the guided exercises. This is not in contrast with his statement in the preface that he hates the phrase "it can be shown", as many of the exercises are, in practice, guided proofs of important results.

Strong Interactions of Hadrons at High Energies

Gribov Lectures on Theoretical Physics

VLADIMIR GRIBOV

PREPARED BY Y. DOKSHITZER AND J. NYIRI

CAMBRIDGE MONOGRAPHS
ON PARTICLE PHYSICS, NUCLEAR PHYSICS
AND COSMOLOGY

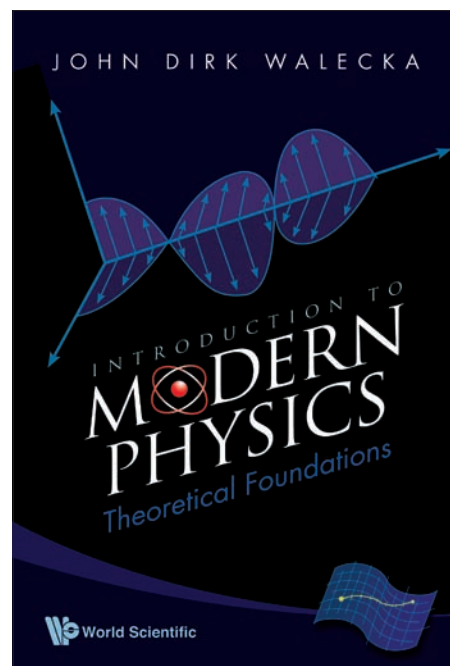
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The only aspect that I can criticize is the poor quality of illustrations, which are far from the high standard of the text. However, this should not discourage readers because the illustrations are clear enough to disclose all of the information that they contain. To balance this negative aspect, I should mention the existence of several appendices, which provide an overview of useful mathematics and extra developments. This is fundamental because the typical reader may not have a deep mathematical background and it also makes the book easier for people who read it to review the basics of 20th-century physics. *Diego Casadei, New York University and CERN.*

Books Received

Proceedings of the Conference in Honor of C N Yang's 85th Birthday: Statistical Physics, High Energy, Condensed Matter and Mathematical Physics edited by M-L Ge, C H Oh and K K Phua, World Scientific. Hardback ISBN 9789812794178, £99 (\$122).

The Conference on Statistical Physics, High Energy, Condensed Matter and Mathematical Physics was held in honour of Chen-Ning Yang's 85th birthday in Singapore in October – November 2007. The conference paid tribute to the breadth and depth of Yang's achievements in physics and science education since he received the Nobel Prize



in Physics 50 years ago. This notable birthday volume is a collection of the presentations made at the conference by many eminent scientists who had worked closely with him or who have been influenced to some extent by his work. The areas covered are: high energies and field theories; statistical physics, condensed matter and biophysics; quantum physics; and other topics, including personal recollections from colleagues and students.

Experimental Neutron Scattering by BTM Willis and CJ Carlile, Oxford University Press. Hardback ISBN 9780198519706, £45 (\$90).

The first systematic experiments in neutron scattering were carried out in the late 1940s using fission reactors built for the nuclear-power programme. Crystallographers were among the first to exploit the new technique but were soon followed by condensed-matter physicists and chemists and, most recently, engineers and biologists. The aim of this book is to provide a broad survey of the experimental activities of all of these users. It should appeal to newcomers to the field of neutron scattering, who may be intimidated by the bewildering array of instruments at central facilities (such as at the Institut Laue Langevin in France, the ISIS facility in the UK and PSI in Switzerland), and who may be uncertain as to which instrument to use.