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Induction Accelerators

By Ken Takayama and Richard Briggs (eds.)

Springer

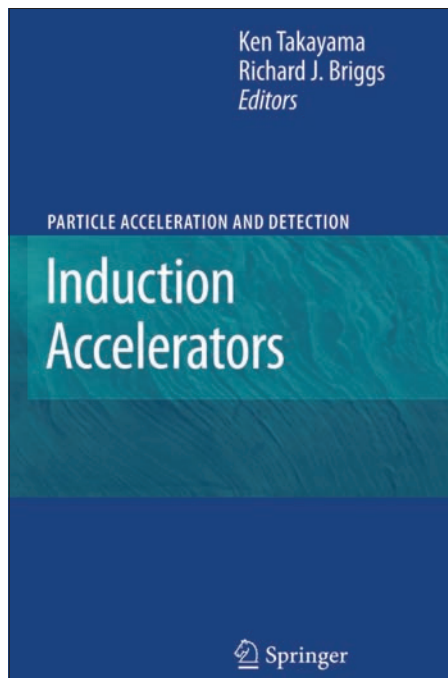
Hardback: €126.55 £108 \$169

Of the nearly 30 000 particle accelerators now operating worldwide, few types are as unfamiliar to most physicists and engineers as induction accelerators. This class of machine is likewise poorly represented in technical monographs. *Induction Accelerators*, a volume of 12 essays by well known experts, forms a structured exposition of the basic principles and functions of major technical systems of induction accelerators. The editors have arranged the essays in the logical progression of chapters in a textbook. Nonetheless, each has been written to be useful as a stand-alone text.

Apart from the two chapters about induction synchrotrons, the book is very much the product of the “Livermore/Berkeley school” of technology of induction linear accelerators (linacs) started by Nicholas Christofilos and led for many years by Richard Briggs as the Beam Research Program at the Lawrence Livermore National Laboratory. The chapters by Briggs and his colleagues John Barnard, Louis Reginato and Glen Westenskow are masterful expositions marked by the clarity of analysis and physics motivation that have been the hallmarks of the Livermore/Berkeley school. A prime example is the presentation of the principles of induction accelerators that, despite its brevity, forms an indispensable introduction by the master in the field to a discussion (together with Reginato) of the many trade-offs in designing induction cells.

One application of induction technology made important by affordable, solid-state power electronics and high-quality, amorphous magnetic materials is the induction-based modulator. This application grew from early investigations of magnetic switching by Daniel Birx and his collaborators; it is well described by Edward G Cook and Eiki Hotta in the context of a more general discussion of high-power switches and power-compression techniques.

Invented as low-impedance, multistage accelerators of high-current electron beams, induction machines have always had the central challenge of controlling beam instabilities and other maladies that can spoil the quality of the beam. Such issues have been the focus of the major scientific contribution of George Caporaso

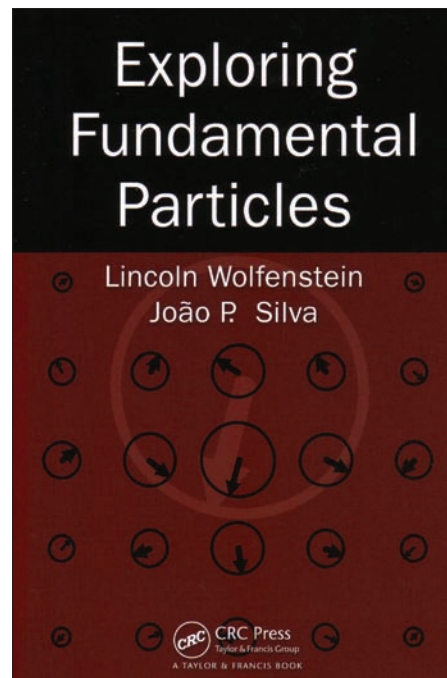


and Yu-Jiuan Chen, who – in the most mathematical chapter of the book – discuss beam dynamics, the control of beam break-up instability and the suppression of emittance growth resulting from the combination of misalignment and chromatic effects in the beam transport.

In ion induction linacs proposed for use as inertial-fusion energy drivers, an additional class of instabilities is possible, namely, unstable longitudinal space-charge waves. These instabilities are analysed in a chapter by Barnard and Kazuhiko Horioka titled “Ion Induction Linacs”. It is followed by a description of the applications of ion linacs, especially to heavy-ion-driven inertial fusion and high-energy density research. These chapters contain the most extensive bibliographies of the book.

The use of induction devices in a synchrotron configuration was studied at Livermore and at Pulsed Sciences Inc in the late 1980s. However, it was not until the proof-of-concept experiment by Takayama and his colleagues at KEK, who separated the functions of acceleration and longitudinal focusing, that applications of induction accelerators to producing long bunches (super-bunches) in relativistic-ion accelerators became a possibility for an eventual very large hadron collider. These devices and their potential applications are described in the final chapters of the book.

Both physicists and engineers will find the papers in *Induction Accelerators*



well written with ample – though not exhaustive – bibliographies. While the volume is not a textbook, it could profitably be used as associated reading in a course about accelerator science and technology. *Induction Accelerators* fills a void in the formal literature on accelerators. It is a tribute to Nicholas Christofilos and Daniel Birx, the two brilliant technical physicists, to whom this volume is dedicated. I recommend it highly.

● William Barletta, director of the US Particle Accelerator School and adjunct professor of physics at MIT and UCLA.

Exploring Fundamental Particles

By Lincoln Wolfenstein and João P Silva

Taylor & Francis; CRC Press 2011

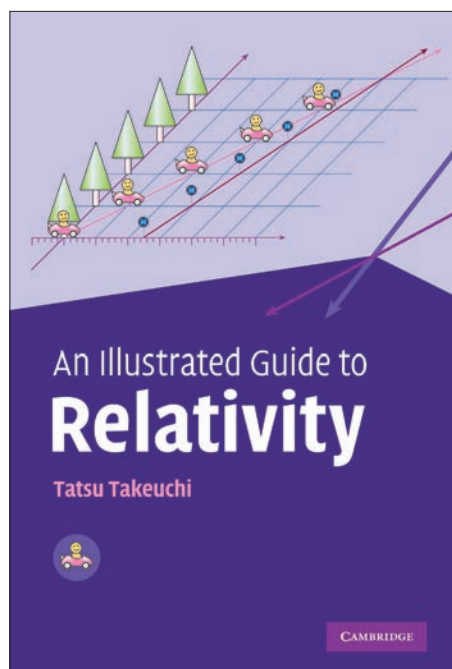
Paperback: £30 \$49.95

E-book: \$49.95

Writing a book is no easy task. It surely requires a considerable investment of time and effort (it is difficult enough to write short book reviews). This is especially true with books about complex scientific topics, written by people who are certainly not professional writers. I doubt that the authors of the books reviewed in the *CERN Courier* have taken courses on how to write bestsellers. Being such hard work, the authors must have good reasons to embark on the daunting challenge of writing a book.

When I started reading *Exploring Fundamental Particles*, I immediately wondered what could have been the reasons

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that triggered Lincoln Wolfenstein and João Silva to write such a book. After all, there are already many “textbooks” about particle physics, both in generic terms and in specific topics. For instance, the puzzling topic of CP violation is described in much detail in the book *CP Violation* (OUP 1999), by Gustavo Branco, Luís Lavoura and João Silva (the same João Silva, despite the fact that João and Silva are probably the two most common Portuguese names). There are also many books about particle physics that address the “general public”, such as the fascinating *Zeptospace Odyssey* (OUP 2009), by Gian Giudice (*CERN Courier* April 2010 p40), which is a nice option for summer reading, despite the somewhat weird title (the start-of-section quotations are particularly enjoyable).

Exploring Fundamental Particles follows an intermediate path. It addresses a broad spectrum of physics topics all of the way from Newton (!) and basic quantum mechanics to the searches for the Higgs boson at the LHC – building the Standard Model along the way. And yet, despite its wide scope, the book focuses with particularly high resolution on a few specific issues, such as CP violation and neutrino physics, which are not exactly the easiest things to explain to a wide audience. The authors must have faced difficult moments during the writing and editing phases, trying hard to keep the text readable for non-experts, while giving the book a “professional touch”.

This somewhat schizophrenic style can be illustrated by the fact that while the book

is submerged in Feynman diagrams, some of them are quite hard to digest (“Penguins” and other beasts), it has no equations at all (not even the ubiquitous $E=mc^2$) – maybe for fear of losing the reader – until we reach the end of the book (the fifth appendix, after more than 250 pages, where we do see $E=mc^2$). The reading is not easy (definitely not a “summertime book”) so, for an audience of university students and young researchers, adding a few equations would have improved the clarity of the exposition.

I also found it disturbing to see the intriguing discussions of puzzling subjects interrupted by trivial explanations on how to pronounce “Delta rho”, “psi prime” etc. These parenthetical moments distract the readers who are trying to remain concentrated on the important narrative and are useless to the other readers. (If you do not know how to pronounce a few common Greek letters, you are not likely to survive a guided tour through the CKM matrix.)

I hope the authors (and editor) will soon revise the book and publish a second edition. In the meantime, I will surely read again a few sections of this edition; for certain things, it is really quite a useful book.

● Carlos Lourenço, CERN.

An Illustrated Guide to Relativity

By Tatsu Takeuchi

Cambridge University Press

Hardback: £45

Paperback: £16.99

E-book: £23

When I was an undergraduate my special-relativity professor, Yashusi Takahashi, was trying to write a book to teach special relativity using diagrams. Certainly, diagrams figured highly in our course material, but so did equations. In *An Illustrated Guide to Relativity*, Tatsu Takeuchi has taken things one step further and produced a textbook about special relativity that uses no equations at all.

This approach works well in the early chapters. The concept of the space–time diagram is introduced for Galilean rest frames and Takeuchi shows how two different rest frames can be superimposed on a single diagram by changing the angle of the grid. However, once he reaches Lorentz frames, I found myself yearning for an equation to give me a more complete picture – beyond just pictures.

That said, the book is well written and entertaining. I like the drawings as well as Takeuchi’s self-deprecating sense of humour. He gets across early on how odd it is that the speed of light is the same in all inertial frames, and shows clearly why this leads to the breakdown of Galilean

transformation – showing that the invariance of the speed of light affects simultaneity.

Each page is self-contained, which makes it easy to get through, and the challenges of special relativity – such as the twin paradox and Lorentz contraction – are well explained. There is even a useful section of exercises at the back that you can use to test your understanding.

So, it’s a worthwhile book. For those who are non-mathematically minded, it is all you need to gain a good understanding of Einstein’s special theory of relativity. For those who like a good equation, it’s still a great companion.

● Catriona Charlesworth, St Jean de Gonville.

Books received

Spectral Distributions in Nuclei and Statistical Spectroscopy

By VK B Kota and Rizwan ul Haq (eds.)

World Scientific

Hardback: £91 \$147

E-book: \$191

This first, comprehensive review of statistical spectroscopy begins with an introductory overview of the subject of spectral distributions initiated by J Bruce French in the 1960s, followed by a collection of original papers that continue to give new insight into the average properties of spectra. The purpose is to highlight the considerable advances made in the application of statistical spectroscopy to nuclear structure and to encourage new directions in random matrix theory, many-body chaos and statistical mechanics of finite quantum systems such as nuclei, atoms, molecules, quantum dots etc.

Physics Over Easy: Breakfasts with Beth and Physics (2nd edition)

By Leonid V Azároff

World Scientific

Hardback: £36 \$54

Paperback: £16 \$24

During a sequence of meals, the author relates the principal features of physics in easy-to-understand conversations with his wife. Beginning with the studies of motion by Galileo and Newton through to the revolutionary theories of relativity and quantum mechanics in the 20th century, this book covers the all-important aspects of electricity, energy, magnetism, gravity and the structure of matter and atoms. The second edition includes nanoparticles, Bose–Einstein condensates, quantum entanglement and quantum computers. It describes our improved understanding of how the universe was formed in an inflationary Big Bang and the life of stars.



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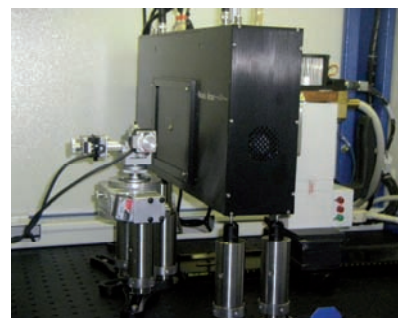
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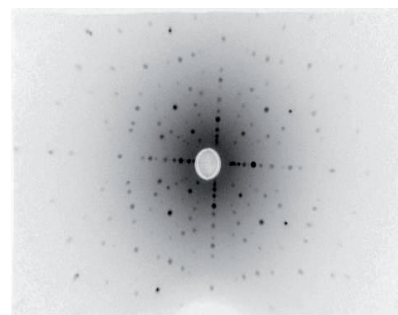
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