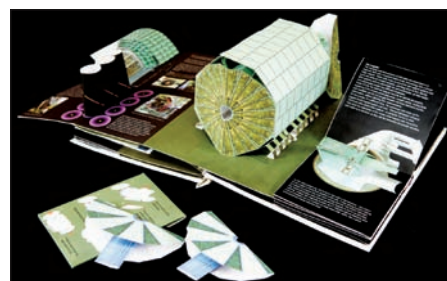
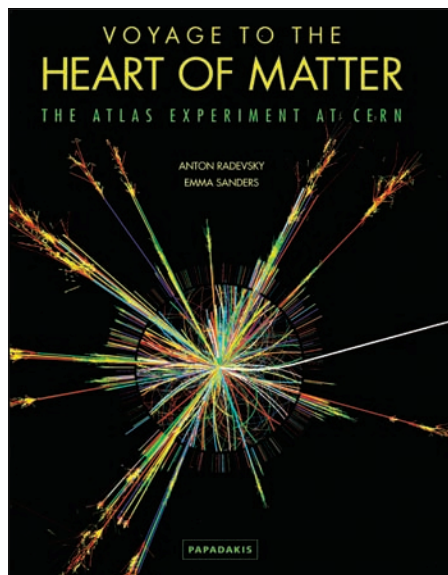


BOOKSHELF

Festive Bookshelf

The year at CERN has been dominated by preparations to restart the LHC and embark on explorations of the high-energy frontier. At the same time, the LHC machine has entered popular consciousness, with worldwide coverage in everything from science magazines to prime-time television.

To help answer the inevitable questions from family and friends, this edition of Bookshelf looks at two books that are aimed at explaining experiments at the LHC to a broader audience, as well as other books that could be considered as presents in this festive season.



Voyage to the Heart of Matter: the ATLAS Experiment at CERN by Anton Radevsky and Emma Sanders, Papadakis. Hardback ISBN 9781906506063, £20.

You would never guess from the title that *Voyage to the Heart of Matter* is a pop-up book about the Large Hadron Collider. And that is a shame because it is an extraordinary work of paper engineering that deserves to stand out on the soon-to-be crowded shelf of popular books about the LHC.

Written by pop-up-book author Anton Radevsky and manager of CERN's Microcosm exhibition Emma Sanders, *Voyage* is only eight pages long yet each turn of the page reveals a pop-up spread that will have you gasping with joy. Most of the corners open up to reveal yet more 3D delights, including delicate reproductions of the ATLAS tracking detectors and a miniature control room, complete with physicists. Others reveal movable elements showing how matter and antimatter annihilate or how showers of particles develop in a calorimeter.

Voyage exploits all three dimensions to wonderful effect. A glorious pop-up universe charts cosmic evolution from the first microsecond, chock-full of quarks and leptons, to the galaxies of present day. Readers are even given the chance to unfurl the ATLAS detector and install the inner detectors and muon chambers.

What is so charming about *Voyage* is the level of detail in the illustrations. You are guaranteed to spot something new each time you read it: the tiny human standing next to

ATLAS; the trigger room; and event displays on the physicists' computer screens.

Voyage does have its flaws, though. For instance, some of the pop-up structures need a helping hand as you open and close the pages. A more serious problem is that the authors know too much about ATLAS and haven't simplified the words enough for ordinary readers. This is all the more apparent because of the book's layout: the words need to be read in order yet the book has so many flaps that there is no clear order. The various detector components would benefit from being labelled too. (One of the pop-up structures remains a mystery to me.)

On balance, the book's charms outweigh its faults. It is somehow fitting that its complex paper engineering reflects the engineering achievements of ATLAS and the LHC. *Voyage* is an enchanting book.

Valerie Jamieson, deputy features editor, New Scientist.

Collider: The Search for the World's Smallest Particles by Paul Halpern, Wiley. Hardback ISBN 9780470286203, €24.90 (£18.99, \$27.95).

As well as opening a new era of fundamental physics research, the LHC is also making its mark on science publishing. There are already several books on the LHC – soon there will be more. Paul Halpern of Philadelphia's University of the Sciences is a prolific author and has produced a book aimed at the North American market.

After a tourist's introduction to CERN,

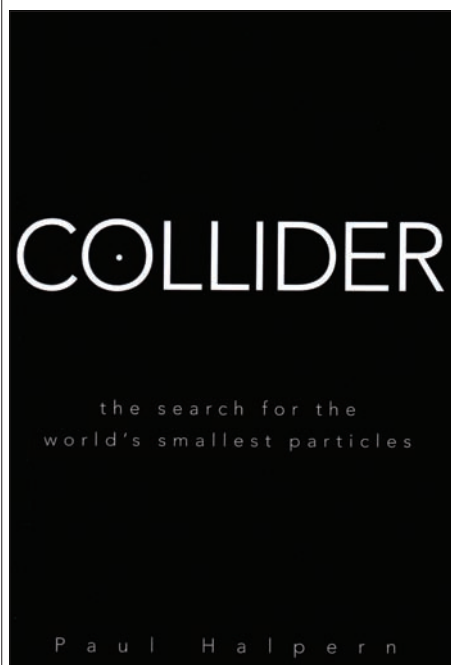
Collider charts the history of the quest to discover and explain the structure of matter. Any book on particle physics has to shoulder this burden. Thus, in a book about 21st-century science, the first illustration is a portrait of Ernest Rutherford.

Unification, as a means to understand as much as possible from a minimal subset of axioms, is a central theme in physics. Halpern points out the aptness of CERN having its home in Switzerland. Just as the country successfully unifies different languages, religions and geographies, so can it be with physics: with imagination and insight, what superficially seems to be highly disparate, in fact reveals deep parallels.

As well as this theoretical understanding, Halpern also traces the history of the particle accelerators that probe the depths of the atomic nucleus and the detectors needed to capture and record their outcomes. After the Second World War, this science became very much a US speciality, with CERN trying to play catch-up as best it could.

With colliding-beam machines providing an additional stage for this research, it was Carlo Rubbia who helped propose the idea of a proton-antiproton collider. However, Fermilab in the US was committed to equipping its ring tunnel with superconducting magnets, so Rubbia knocked on CERN's door instead.

There, prescient minds saw the value of the scheme. In 1983 came the landmark discovery of the W and Z particles – the carriers of the unified electroweak force (p30). With this collider, Europe had not



only caught up but overtook the US, where it was a blow to national scientific prestige. As Halpern writes: "Like baseball, accelerator physics had become an American pastime, so it was like losing the World Series to Switzerland."

Piqued, the US mobilized for the mother of all colliders, its Superconducting Supercollider (SSC). Halpern recalls the SSC era and points out how the machine, primarily a US venture, was handicapped by its limited international horizon.

After the sudden cancellation of the SSC, the less ambitious LHC collider was alone on the world stage and CERN, itself an international organization, knew how to manage such ventures. The SSC had been a green-field site: CERN had the advantage of an existing tunnel, built to house its electron-positron collider, LEP. More credit should be given to the CERN pioneers who had presciently stressed right at the start that this tunnel should be made wide enough to accommodate big magnets for a later, more ambitious machine. Thanks to such foresight, the LHC could fit inside CERN's existing subterranean real estate.

In 2008 the commissioning of the LHC was overshadowed by a puerile phobia: black holes from the machine would swallow the planet. Halpern creditably blows away such absurdity. It often appears as though the human race is not happy unless it has something to worry

about. In 2009 the panic about purported black holes at the LHC seems to have become obscured by other worries.

Collider is timely, instructive and comprehensive. However, its transatlantic view of Europe sometimes gets a little out of focus. With a population of 7600, the thriving French town of Ferney-Voltaire near CERN is not "little touched by modernity". This "village" gives France the novelty of separate access to Geneva airport, and its proximity to the international scene in neighbouring Geneva has played a key role in the development of French secondary-school education. On a more important historical note, Isidor Rabi may have suggested the idea of what eventually became CERN, but he did not create it.

Gordon Fraser, Divonne-les-Bains.

Nothing: A Very Short Introduction

by Frank Close, OUP. Paperback ISBN 9780199225866, £7.99 (\$11.95).

In 2003, a travel writer called Bill Bryson caught the imagination of many with a popular-science book called *A Short History of Nearly Everything*. This was in many ways the perfect antidote to Stephen Hawking's intellectually dazzling bestseller *A Brief History of Time*, which left many readers without a physics background perplexed. Reading Frank Close's book *Nothing – A Very Short Introduction*, I am reminded of both Bryson and Hawking at once.

Do not be fooled by the title. Like Bryson, Close covers nearly everything – or at least nearly everything in the history of physics – as he attempts to grapple with the philosophical meaning of nothing through the ages, and how physicists' concept of a pure vacuum has today become cluttered with virtual particles. And like Hawking, he succeeds in being succinct: under 150 pages in this highly portable volume (Bryson's weighty tome, at nearly 500 pages, was short only in name).

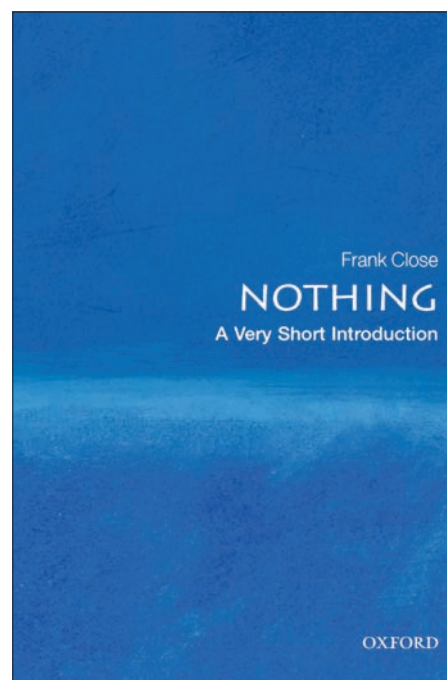
In terms of approachability for the uninitiated, Close lies somewhere between Bryson and Hawking. Bryson's advantage in exposing scientific concepts was that, until he started writing the book, he didn't understand many of those concepts himself. So he erred on the side of simplicity. Close succeeds most of the time in keeping the science simple and finding useful analogies for difficult concepts. Fields that permeate the vacuum are introduced through an analogy with weather

maps, which chart atmospheric-pressure variations, for example.

But like many an expert who has spent his life steeped in science – Close is professor of physics at Oxford University – he sometimes overlooks the implicit knowledge he carries. After an admirable introduction to zero-point energy in terms of a perpetually trembling quantum pendulum, for example, he goes on to introduce the Casimir effect by stating that, "The Void is a quantum sea of zero-point waves, with all possible wavelengths, from those that are smaller even than the atomic scale up to those whose size is truly cosmic." It is precisely at such conceptually challenging junctures that the attention of the uninitiated may begin to wander.

That said, the book never dwells too long on any one topic to become tedious. Rather, it romps along through a list of some of the most exciting physics breakthroughs of the past century. And all of these, in Close's carefully woven story, have something to do with nothing. Black holes, the cosmic microwave background, the Higgs boson are all there, with a respectful nod to CERN where Close headed the communication and public education activities between 1997 and 2000.

When it comes to filling Christmas stockings, Close's book would be a good choice for a teenager with a burgeoning interest in physics. It has a healthy balance of clear exposure of known facts and tantalizing



glimpses of the complexity of science at its cutting edge, plus occasional reminders that if the reader really want to understand this stuff, mastering mathematics is essential. Besides, its handy format will squeeze easily into even the smallest of stockings.

François Grey, Tsinghua University, Beijing.

Why Does $E=mc^2$? (And Why Should We Care?) by Brian Cox and Jeff Forshaw, Perseus Books. Hardback ISBN 9780306817588, £12.99 (\$24.00).

A century after Albert Einstein published his theory of relativity, and more than half a century after his death, the public imagination is still stirred by all things Einstein. Any writer of physics for non-scientists knows that Einstein is the goose that keeps laying the golden eggs. Just as a comedian knows that a punch to the crotch will always make 'em laugh, a physicist knows that Einstein will make 'em think. Brian Cox and Jeff Forshaw are recent additions to the "World of Einstein" popularizations and their book *Why Does $E=mc^2$? (and why should we care?)* does a respectable job of bringing the reader into that world. More importantly, it is also a laudable attempt at leading the readers to more modern connections.

The first half of the book explains special relativity in detail and with clarity. The more casual reader might be put off by the long chapters and the long paragraphs, with

sometimes difficult transitions between concepts, but the elements needed to understand are there for the determined reader. I especially liked the discussion on how to think about invariant lengths in space-time. It is unfortunate, however, that more care was not taken in the figures. Some appear more akin to what is found in a physics-journal article than is suitable in a book about popular science. Nevertheless, that minor point does not damage the discussion much.

The second half of the book discusses more modern developments, with interesting descriptions of pulsars, black holes, nuclear fusion, the Higgs mechanism and more. The connection to $E=mc^2$ is rather stretched in places, but I did not mind. At times the discussion here becomes quite complex. For example, the Standard Model Lagrangian equation is given in chapter 7, accompanied by pages of explanation that I am afraid may go over the heads of many readers. And again, the figures are complex, including the one-loop QED diagram of e^-e^- scattering. This could be viewed as a plus, however, in that the authors are not shying away from trying to explain more advanced material than is normally attempted in popular books. Furthermore, the basic points that the authors wish the reader to be sure to get are explained patiently, and the anecdotes are entertaining.

Given the strengths of this book, and the level at which it is pitched, I would feel most comfortable recommending it to, for example, determined and precocious teenagers who are already studying physics, but who want to get an introduction to relativity and modern ideas more quickly than the school curriculum allows. The book should hold their interest, and be beneficial to them when they study it again in a more rigorous context.

James Wells, CERN.

Facetten der Physik: Höhepunkte Moderner Physikalischer und Astronomischer Forschung by Georg Wolschin, Shaker Media. Hardback ISBN 9783868580600, €39.90.

The 20th century was marked by many revolutionary advances in fundamental physics, from the microscopic world of particle physics to the cosmological scales of general relativity – topics presented and discussed in a multitude of books, many of them for a general audience. The most recent experimental observations, however,



are not yet included in those "text books" and the general public can only learn about them through articles published in scientific magazines.

Wolschin's book presents a collection of individual articles published between 1998 and 2009 on the highlights of experimental research in modern physics and astronomy. The 45 contributions, decorated with many colourful figures, images and computer simulations, were originally published in the magazines *Spektrum der Wissenschaft*, *Bild der Wissenschaft* and *Sterne und Weltraum*. For the book edition, each original article (5–10 pages long) is complemented by a short paragraph reflecting the latest progress in the corresponding topic. In general, the author succeeds quite well in explaining at a relatively simple level the many complex phenomena addressed, targeting the readers of popular-science magazines.

While astronomy and astrophysics provide the centre of gravity of this compilation, many other research topics are addressed, including practically all branches of high-energy physics, as well as cancer therapy with ion beams, quantum entanglement, etc. The reader can, for instance, learn about WMAP's measurement of the temperature fluctuations in the cosmic background radiation and how their spectral analysis probes the age and geometry of the universe. Or about ESA's recently launched Planck satellite, which will perform

why does $E=mc^2$?



BRIAN COX & JEFF FORSHAW

improved measurements and further test the cosmological models.

Triggered by the world year of physics (2005) and sprinkled with interviews with well known physicists, several articles discuss Einstein's ideas and their experimental testing. One of these tests involves the search for gravitational waves. In other articles, Wolschin describes the Laser Interferometer Space Antenna (LISA), a sophisticated and highly sensitive triangular laser-interferometer system that will be based on three satellites placed 5 million kilometres apart. The observation that neutrinos are not massless (one of the most interesting experimental results of recent years) also merits considerable attention in the book, requesting an "extension of the Standard Model of particle physics".

The format of the book is somewhat puzzling, with the articles ordered chronologically, starting with the most recent. After reading the latest article on neutrino physics, the other three seem repetitive. The

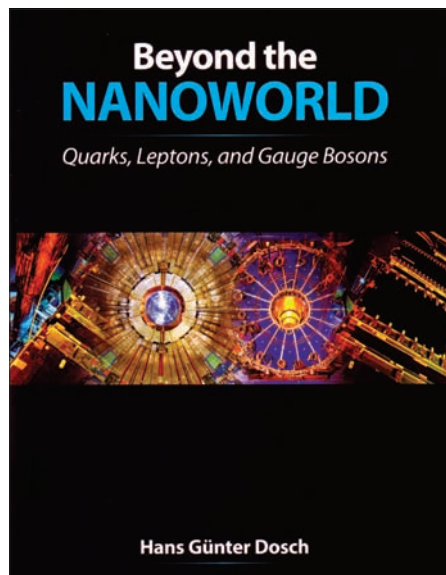
book would have benefited from organizing the articles by topic and merging the ones with similar contents.

Hermine K Wöhri, Laboratório de Instrumentação e Física Experimental de Partículas, Lisbon.

Books received

Beyond the Nanoworld: Quarks, Leptons and Gauge Bosons by Hans Günter Dosch, A K Peters. Hardback ISBN 9781568813455, \$39.

Elementary particles are a long, long way beyond the "nanoworld" of molecules, being firmly embedded in the "femtoworld". This primer on particle physics takes the reader on the journey from the first discoveries of subatomic structure to today's Standard Model, following both experimental and theoretical developments. It tries to avoid mathematics, but doesn't shy away from difficult concepts; readers are spared equations, but they need patience. It was originally written in German as *Jenseits*



der Nanowelt, where it challenges Harald Fritzsch's classic *Quarks, Urstoff Unser Welt*. The English version covers similar ground to Frank Close's *The New Cosmic Onion*.



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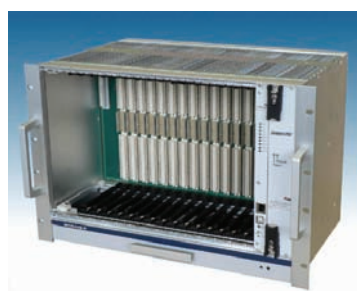


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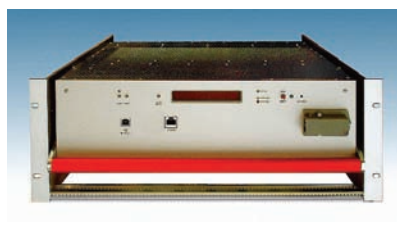
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