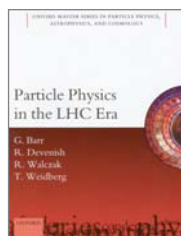


Particle Physics in the LHC Era

G. Barr, R. Devenish, R. Walczak, and T. Weidberg

Oxford U. Press, 2016. \$125.00 (432 pp.). ISBN 978-0-19-874855-7



Particle physics is undergoing a midlife crisis. Born out of nuclear physics and cosmic-ray physics in the second half of the 20th century, it went through a turbulent adolescence of rapid discoveries in the 1960s and 1970s and entered an adult phase of spectacular recognition and success during which precision measurements confirmed earlier intuitions one by one. With the discovery of the Higgs boson at the Large Hadron Collider (LHC) in 2012, particle physics checked its last dream off the list and settled into a somewhat affluent lifestyle. In the short span of half a century, the discipline has made enormous progress and has achieved a precise understanding of the fundamental building blocks of ordinary matter.

And yet something is missing. Something big, actually. We know that most of the universe is made of mysterious substances—namely, dark matter and dark energy—which we do not yet understand. We also have no firm grasp on the origin of the parts of the universe that we do understand. The LHC, the same shiny machine that has delivered some incredibly satisfying results, has also so far disappointed hopes that it would unveil what lies ahead.

So, if particle physics were a person, they might decide to go into therapy. The therapist might suggest sitting down and writing out all their past deeds, how those incredible feats were achieved, and what it all means. The result would be something very close to *Particle Physics in the LHC Era* by Giles Barr, Robin Devenish, Roman Walczak, and Tony Weidberg.

This is indeed a valuable textbook, written by recognized experts in experimental particle physics and aimed at students at the advanced undergraduate or early graduate level. It has two ambitious goals. The first is to cover the whole field of particle physics. Its topics range from the hardware details of particle detectors to the intrinsic properties of the Higgs boson, from explaining why LHC

magnet coils are made of peculiarly twisted filaments to discussing the cosmological constant and the accelerating expansion of the universe.

The second goal is, in the words of the authors, to “teach the maximum amount of physics with the minimum level of maths.” The book starts with a self-contained chapter that introduces the basics and covers such mathematical tools as fundamental symmetries and some group theory. It moves on to a discussion of the hardware of particle physics, specifically accelerators and detectors, and then covers the different aspects of the standard model and its experimental tests. Along the way, the authors discuss the Klein–Gordon and Dirac equations, the principle of gauge symmetry, electroweak interactions, quantum chromodynamics, charge–parity violation, neutrino oscillations, and the Higgs boson. Both goals are largely achieved.

As with any ambitious endeavor, there are weaknesses and omissions. The most obvious, reflected even in the title, is the admitted bias toward LHC physics.

As a result, some parts of the book might soon be outdated, and more importantly, experimental programs such as those involving neutrino or astroparticle physics receive a somewhat cursory treatment. On a more formal level, the treatment of Feynman diagrams, the fundamental tool for actual computations in quantum field theory, falls slightly short: Given the amount of theoretical material already covered in the initial chapters, simply providing the fundamentals of Dirac matrix algebra would have empowered the reader to compute basic amplitudes and processes, but those mathematical preliminaries are instead left to the Further Reading sections. Other topics that perhaps deserved mention are statistics and data analysis, which are crucial for budding particle physicists.

Overall, though, *Particle Physics in the LHC Era* is a very successful enterprise. The book is a worthy successor to classic texts like Donald Perkins’s *Introduction to High Energy Physics* (Addison-Wesley, 1972) and Francis Halzen and Alan Martin’s *Quarks and Leptons: An Introductory Course in Modern Particle Physics* (Wiley, 1984). This volume has the potential to bring a new generation of particle physicists to the brink of current knowledge and help prepare them to go out and push the frontier.

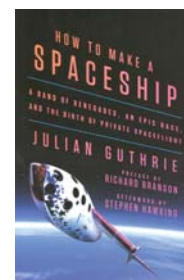
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How to Make a Spaceship

A Band of Renegades,
an Epic Race, and the Birth of Private
Space Flight

Julian Guthrie

Penguin Press, 2016. \$28.00 (448 pp.). ISBN 978-1-59420-672-6



Hanging in the National Air and Space Museum’s Boeing Milestones of Flight Hall is *SpaceShipOne*, the winner of the Ansari XPrize in 2004. The \$10 million prize was awarded for the first piloted, non-governmental spacecraft to fly twice in two weeks above 100 kilometers—the now widely accepted, if arbitrary, definition of where outer space begins. The XPrize’s aim was to stimulate private space tourism. A dozen years after the prize was

awarded, we are still waiting for sub-orbital tourist flights to begin.

Julian Guthrie’s book about the XPrize, *How to Make a Spaceship: A Band of Renegades, an Epic Race, and the Birth of Private Space Flight*, is structured around intertwined biographical segments. The first half is largely about Peter Diamandis, the XPrize’s creator. The son of a doctor in the New York City suburbs, Diamandis was eight years old when he watched Neil Armstrong and Buzz