environment and in certain circumstances facilitating the growth of other species.

Nonlinear Physics of Ecosystems surely will contribute to the development of a newly emerging interdisciplinary research field at the interface of ecology and pattern formation. I would recommend it to graduate students who want to conduct research in mathematical ecology or physics applied to spatial-ecology problems. A minor caveat: I wish the book had included exercises to help students reinforce and test their understanding; maybe it will in the next edition.

Nonetheless, it could be used either as a main or supporting textbook in a one-semester course for advanced undergraduate or graduate students in physics or ecology or in a course with a mixed audience of students from both disciplines. I also warmly recommend the book for nonlinear physicists, applied mathematicians, and theoretical ecologists working on those cutting-edge environmental interdisciplinary problems.

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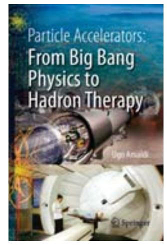
Particle Accelerators

From Big Bang Physics to Hadron Therapy

Ugo Amaldi
Springer, 2015. $34.99 (284 pp.).
ISBN 978-3-319-08869-3

Particle Accelerators: From Big Bang Physics to Hadron Therapy takes us on a fascinating odyssey of accelerator history and applications. Author and prominent CERN scientist Ugo Amaldi's principal aim is to highlight and praise the role of the machine builders. In doing so, he borrows a comparison made by particle theorist Victor Weisskopf, CERN director general from 1961 to 1965. Weisskopf likens accelerator builders to the creators and captains of the ships that brought Christopher Columbus and his crew to the Americas; experimentalists to those who set foot on the new lands and described them; and, somewhat self-mockingly, theorists to those who stayed behind in Europe and made the prediction that Columbus would arrive at India. Amaldi's book also confirms the view that developments in science are driven by the achievements of many people across many generations, and that we are indeed standing on the shoulders of giants.



The first version of *Particle Accelerators* was published in 2012 and written in Italian. In 2013 it won a science communication award from the Italian Book Association. Following that success, the author considerably expanded his text, adding many useful details. In its present form, the book contains many recollections of CERN; it would definitely warm the heart of anyone who worked and lived in that wonderful scientific mecca.

Particle Accelerators, which is aimed at the general public, is filled with intriguing analogies, metaphors, and humor. For example, the author describes the uncertainty principle as the process of taking a "loan of energy" from the "Heisenberg bank," with the unusual twist that the greater the loan amount, the earlier it matures. He compares the Bevatron at Lawrence Berkeley National Laboratory to a 10 000-ton "cracker of invisible nuts" and electron–positron annihilation to the disappearance of two colliding strawberries giving rise to a flood of bananas or apples. And he suggests what he considers a compact and more meaningful nomenclature for the three neutrinos: neutrino for the electron neutrino, neutretto for the muon neutrino, and neutrotto (or fatter neutrino) for the tau neutrino.

After telling the story of the early accelerator builders, the book goes on to particle physics, the field that has most benefited from the technology. Topics covered include the standard model and its extensions; dark matter; dark energy; supersymmetry; and string theory, which the author believes provides the most likely explanation for symmetry breaking. If a subsequent edition is written, I hope it includes brief and simple descriptions of the many phenomena and methods that are mentioned but never explained—for example, synchrotron radiation and the supernova standard candles that led to the idea of an accelerating universe.

Medical applications are featured in the book's concluding section, which describes in popular terms the basics of x-ray and particle imaging and tumor treatment. Readers will learn about many technical details and enjoy some intriguing stories along the way. For instance, the first—and for a long time, the only—interest in an early article outlining computerized tomography came from a Swiss center for avalanche research, which wanted to use the technology to find objects—like lost skiers—trapped in snow.

Amaldi captures the romantic spirit of the early days of particle physics experiments. He also touches on the cooperation and competition between the continents. Surprisingly, at least at the time this edition was published, all bosons since 1948 had been discovered in Europe and all fermions in America—a peculiar sort of symmetry breaking.

The author also occasionally makes what some readers may consider as frank and provocative remarks. For example, he states that the Large Electron–Positron Collider could have discovered the Higgs more than a decade ago had he and his colleagues convinced the CERN directorate to invest substantially in upgrading the superconducting RF cavities. Amaldi also laments that Bruno Touschek and Gersh Budker were not rewarded with the Nobel Prize for their role in the development of electron–positron colliders; he suggests that had the scientists been working in the US—where the main action was—they would have received the honor. In any case, such comments are nicely balanced by wonderful stories of cooperation, such as between Brookhaven National Laboratory and CERN during the building of the CERN Proton Synchrotron.

Particle Accelerators culminates with an inspiring story of the development and creation of the Italian National Center for Oncological Hadron Therapy, a great achievement for Amaldi, who put an enormous amount of effort and energy into its creation. He is now working to develop a novel linac for proton therapy. These initiatives prove the author's own maxim that "physics is beautiful and useful."

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Gravity

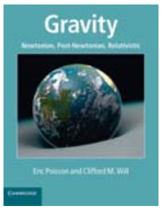
Newtonian, Post-Newtonian, Relativistic

Eric Poisson and Clifford M. Will
Cambridge U. Press, 2014. $80.00
(780 pp.). ISBN 978-1-107-03286-6

Gravity: Newtonian, Post-Newtonian, Relativistic is not the usual relativity text. But it's the one you need if you actually want to calculate something astrophysical without a supercomputer. I know of no other text that compares with this compendium of tricks for calculating observables in the large fraction of the universe that is not near an event horizon.

Eric Poisson and Clifford Will, two world-renowned leaders in the field, have produced the ideal manual for anyone who wishes to do calculations relevant to current experiments or upcoming gravitational-wave observations.

In every area of physics, a few problems can be solved exactly, but most others are approximated. In general relativity the exact solutions are fewer than usual, and almost every point of contact between theory and experiment involves some sort of approximation. At the heart of *Gravity* are those approximations and how they connect Newtonian to general-relativistic gravity. In practice, making the connections is a task notorious for its conceptual issues and involved calculations. The authors' exceptionally clear writing and deep understanding of the material, however, render their explication accessible at the graduate-student level. (As a graduate student, I relied heavily on the authors' publications that led to this textbook.)



The first three chapters of the book treat Newtonian gravity. The authors go beyond the standard point-particle orbits and collect classic methods to compute orbits perturbed by spins, tides, and other phenomena associated with extended structures. They also consider perturbations, such as Newtonian perihelion precession and the Kozai mechanism, that arise from additional point particles. Beyond considering orbital dynamics, they also solve classic problems in stellar structure and perturbations. Previous treatments of those topics are scattered throughout the literature, across subfields from astronomy to geophysics to theoretical physics, and over several centuries of notation and terminology changes. The clear, unified presentation in *Gravity* is a must-read for anyone wishing to absorb the material efficiently.

Chapters 4 and 5 are a whirlwind tour of special and general relativity, intended as a refresher rather than as an introduction. Still, the authors manage to work in lucid treatments of the classic applications of Schwarzschild spacetime, particle orbits, and relativistic stellar structure. The next five chapters form the core of the book. They lay out the fundamentals of the post-Minkowski (weak-field) and post-Newtonian (slow-motion) approximations crucial to almost all calculations tied to experiments. Most importantly, those chapters show how to solve problems relevant to, among other things, GPS timing, the deflection and lensing of light, the precession of binary pulsars, and *Gravity Probe B*, the satellite mission to measure spacetime curvature near Earth.

The last three chapters—11, 12, and 13—cover in depth three modern applications of the post-Minkowski and post-Newtonian formalisms. Chapter 11 discusses gravitational waves, a topic of great current interest because Advanced LIGO (Laser Interferometer Gravitational-Wave Observatory) and its sister projects are preparing to collect data. The authors show how to go beyond the quadrupole formula to compute gravitational waveforms to the extremely high accuracy needed for upcoming searches; to do so, one needs to include such terms as the nonlinear tails in the post-Newtonian approximation. That is an enormous undertaking—much like the high-order computation of the fine structure constant in quantum electrodynamics—but one that is crucial to guiding the data analysis.

Chapter 12 covers an offshoot of gravitational-wave research—the radiation-reaction problem. Historically, physicists needed to understand the radiation reaction to shore up the initially shaky foundations of gravitational-wave theory. Things went downhill for decades after Albert Einstein's first paper on waves got the energy flux wrong by a factor of two; also, Einstein relied on an unexamined energy balance argument. In the future, accounting for the radiation-reaction force will be crucial for computing gravitational waveforms and conducting searches for them in the data of any descendant of *LISA* (*Laser Interferometer Space Antenna*), a proposed spaceborne gravitational-wave detector.

Chapter 13 closes the book with a self-contained summary of alternative theories of gravity. It updates Will's classic text, *Theory and Experiment in Gravitational Physics* (Cambridge University Press, 1981), by covering the current constraints and those soon to come with gravitational waves.

Various accessories enhance the main text. For example, the homework problems, which range from easy to worthy of a journal article, often feature the computation of a number relevant to a current experiment or observation. Nondistracting figures and tables illustrate key points. And text boxes form interesting asides, providing some history or extra calculation without overwhelming the main text.

Poisson and Will's *Gravity* is a great textbook for a special-topics graduate course after the introductory relativity course, a crucial study aid for anyone learning about astrophysical relativity and gravitational waves, and a lifelong reference for career researchers.

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