

BOOKS

Charles Townes: A Memoir of a Complex and Productive Life

How the Laser Happened: Adventures of a Scientist

Charles H. Townes
Oxford U. P., New York, 1999.
200 pp. \$49.95 hc
ISBN 0-19-512268-2

Reviewed by Steven Chu

In the middle of a dinner party given in honor of Arthur Schawlow in October 1998, Schawlow's 83-year-old brother-in-law, Charles Townes, suddenly looked up and said to me: "You will have to excuse me, but I need to make a phone call. I'll be back in a few minutes." His wife apologized, adding with a hint of exasperation, "Charlie does this all the time. Whenever his students are 'running,' he has to know what the data look like."

How the Laser Happened is an autobiographical account of the still-vibrant career of one of the major figures of 20th-century physics. Charles Townes's contributions range from the development of microwave spectroscopy, the coinvention of the maser and the laser, and seminal research in infrared and microwave astronomy to university administration and service as adviser to the government on science and defense policy. The memoir is filled with personal anecdotes that provide insight into an immensely original thinker and scientist of enormous energy and prolific output.

The book gives us vignettes from Townes's early childhood—growing up on a family farm in Greenville, South Carolina, where Southern-planter gentility blended with competitive Yankee inventiveness. He writes to his older sister at the age of ten, "You have asked me what I wanted for Christmas. I want mostly hardware . . . some tin-shears, some money to buy some iron-and-wood bits (as I want a particular size, I had rather

pick out my own)." This early funding request was used in a competition with his older brother in which their father awarded "a patent for the one who did something first."

While he was attending Furman University in Greenville, a local college of 500 students, Townes's aptitude for mathematics and machinery led him to physics. He recalls teaching himself special relativity in the summer of his junior year and reaching "the startling conclusion that Einstein had made a mistake in his logic. I went to lunch, and it was a heady few hours until I came back, sat down again with the book and decided: no, I was wrong and Einstein had gotten it right after all. Despite the false alarm, it was an inspiring moment. It absolutely captivated me that, from a few simple equations, one could reach such profound and strange conclusions about the world."

In spite of his keen aptitude, hard work (and obvious self-confidence!), Townes's career path was not without setbacks that would later turn into blessings. Unable to secure a graduate fellowship at the schools to which he applied, he enrolled at Caltech as an unsupported graduate student. He did very well there and was offered a research position at Bell Laboratories. Soon after he arrived at Bell Labs, however, he was told to switch from his beloved physics and work on radar bombsights. This forced entry into microwave engineering formed the basis of his work on the microwave spectroscopy of molecules and the invention of the maser. Later in his career, he became MIT's first provost, but he was passed over as its next president. In response, he concentrated on science and launched a vigorous program in infrared and microwave astronomy.

A recurrent theme in the book is the haphazard twists and turns in a career heavily influenced by the scent of promising directions. For example, the invention of the maser was stimulated by Townes's desire to study the rich molecular spectra at a frequency inaccessible with conventional microwave sources. Unable to scale down conventional microwave cavities to smaller dimensions, he inverted the problem and exploited the quantum

properties of the molecular resonators he wanted to study to construct a fundamentally new electromagnetic source.

In Townes's quest for a source of even shorter microwave wavelengths, he writes, "the mathematics governing maser action . . . suddenly became clear to me: it is just as easy and probably easier to go down to really short wavelengths . . . as to simply go down one smaller step at a time. This was a revelation, like stepping through a door into a room I did not suspect existed." In collaboration at Bell Laboratories with a former postdoc, Arthur Schawlow (who had married Townes's sister, Aurelia), he then worked out several critical details of the "optical maser."

A chapter entitled "The Patent Game" gives a fascinating account of the patent disputes surrounding the maser and the laser. Townes discusses a series of high-stakes court battles, beginning with litigation by the Research Corp, which held Townes's maser patent, against Bell Labs, which held Schawlow and Townes's laser patent. Bell Labs was using maser amplifiers in its satellite communications and threatened to contest the maser patent rather than pay royalties. Spectra Physics, an early laser company, did challenge the maser patent, arguing that it had been filed more than a year after a "publication," in the form of an internal quarterly report of the Columbia Radiation Laboratory, that had found its way onto the shelves of the Harvard University library.

The well-publicized challenges to the Schawlow-Townes laser patent by Gordon Gould, inventor and former graduate student at Columbia University, are also discussed. The facts presented in this book seem consistent with other third-party renditions of the dispute and the court decisions I have reviewed. However, the interpretation of these facts is still a touchy subject, and there remain differences of opinion as to who deserved various patent rights. Unlike the more transparent scientific literature, it may ultimately be impossible to sort out the conflicting claims, since much of the evidence relevant to patents is in private note-

STEVEN CHU, [cowinner of the 1997 Nobel Prize for Physics], is professor of physics and applied physics at Stanford University. While a graduate student at the University of California, Berkeley, he began to use the laser as a guiding light in search of new adventures.

books. Also, legal decisions are often decided by arguments based on a fine-tuned interpretation of the law rather than on scientific merit or common sense. In several cases, for both Townes and Gould, clever and dogged legal representation backed by huge financial resources won the day.

Townes also discusses his role in shaping US science and defense policies. In his account of his interactions as an adviser for the military and for NASA, as a founding member of Jason (a group of academic scientists who meet to consider defense and related technical issues), and as vice president and director of research for the Institute for Defense Analyses, we become privy to formerly classified debates in which Townes and other advisers wrestled with science-policy questions and engineering choices.

How the Laser Happened is more than a chronicle of a stellar career; it is full of glimpses into the forces that guided Townes. The memoir may not satisfy all of those who contributed to the development of the laser, but then it is unlikely that any account, no matter how even-handed, could satisfy everyone. Readers should relax and savor the frequent moments of reflection, where Townes reveals his personal insights. "I am not at all sure," Townes writes, "that the public has a clear idea of how scientists get started and how they work." For young scientists at the beginning of their careers, this book will provide an inspiring case history of how an outstanding physicist got started and went on to do great science.

Advanced LabVIEW® Labs

John Essick
Prentice-Hall (Simon & Schuster),
Upper Saddle River, N.J., 1999.
397 pp. \$28.00 pb
ISBN 0-13-833949-X

In the world of computer-based data acquisition and control, the graphical interface program LabVIEW, from National Instruments Corp, is so ubiquitous that in many ways it has become the laboratory standard. To date there have been approximately 15 books introducing LabVIEW to the reader. John Essick's *Advanced LabVIEW Labs*, however, takes a completely different approach from all of the previous treatments.

In the more standard treatments of LabVIEW, such as *LabVIEW Graphical Programming: Practical Applications in Instrumentation and Control* by Gary W. Johnson

(McGraw-Hill, 1997), the emphasis has been on programming LabVIEW to create a virtual instrument (VI) on the computer for interfacing to a laboratory instrument.

These previous LabVIEW discussions have been concerned mainly with teaching the researcher to use G, the graphical programming language developed by National Instruments and used in LabVIEW. Without going into details here, G incorporates the usual loops, arithmetic expressions, and the like that are found in many programming languages, but in an iconic or graphical environment. The net result is that LabVIEW contains all of the standard methods needed for interfacing to instruments, data acquisition, data analysis, graphics, and the methodology needed to incorporate into LabVIEW programs written in other languages.

Before he became involved with LabVIEW, Essick had developed a series of experiments for an upper-division laboratory course on computer-based instrumentation. His observation was that, while many students had the necessary background in computer programming languages, other students had virtually no idea what was involved in writing a computer program, let alone a computer-based interfacing program. Thus the aim of his book was not only to be a tool to help teach computer-based instrumentation techniques, but also to be a way for the beginner to experience the writing of a computer program. Essick sees LabVIEW as the "perfect environment in which to teach computer-based research skills." With this as his goal, he has succeeded admirably!

Each of the twelve chapters in the book is a laboratory assignment suitable for a ten-week course. The first topic introduces the "while-loop" and waveform chart VIs. After learning how to launch LabVIEW, the student is introduced to such LabVIEW functions as sine, cosine, and the like. The beauty of this and subsequent chapters is that the student is introduced immediately to computer-based instruction and the usefulness of having the results displayed in graph form on the screen. At each point along the way, the student is introduced to another LabVIEW operation or function as well as such subjects as spreadsheets for data storage, numerical integration, Fourier transformations, and curve-fitting algorithms. The last few chapters deal with computer-based instrumentation—the overall purpose of the learning module. Computer-based laboratory projects such as convert-

ing analog to digital and digitizing oscilloscopes are also treated in detail. *Advanced LabVIEW Labs* finishes with a discussion of GPIB (general purpose interface bus) interfacing, and the student is then asked to create an operating VI for temperature control.

This is an excellent text. It is both a treatise on LabVIEW and an introduction to computer programming logic. Any programmer who is trying to learn how to interface computers to instruments and to understand top-down programming and other programming language concepts should read this book.

ERIC D. JONES

Sandia National Laboratories
Albuquerque, New Mexico

Basic Ideas and Concepts in Nuclear Physics: An Introductory Approach

Kris Heyde
IOP, Philadelphia, 1999. 524 pp.
\$156.00 hc (\$57.00 pb) ISBN 0-7503-0534-7 hc (0-7503-0535-5 pb)

The second edition of Kris Heyde's 1994 textbook on nuclear physics is a worthy successor and a welcome addition to a field with a shortage of undergraduate/graduate textbooks. As did the original, the new edition, presents essentially all the basics of the subject in a thorough, readable manner, with an emphasis (roughly 60% of the book) on the topic of nuclear structure, the author's forte. The mere 22 pages dedicated to nuclear reactions in the current version, however, does not provide a complete survey of this topic. Thus, the book remains limited compared to such all-inclusive nuclear physics textbooks as *Introductory Nuclear Physics* by Kenneth S. Krane (Wiley, 1988) and *Introductory Nuclear Physics* by Samuel S. M. Wong (Prentice Hall, 2nd edition, 1999).

Most of the revised and new material in the second edition deals with recent developments in nuclear structure theory. This includes, for example, a new chapter on nuclei far from stability, as well as additions to existing chapters regarding the shell model Monte Carlo method, new extensions to the interacting boson model, and superdeformed and identical bands. The most significant addition is the introduction of three sets of homework problems following the first three major sections on nuclear constituents and characteris-