fore giving a large list of URLs (including the most important content sites), he discusses the major search engines, pointing out their pros and cons. The URL list and the many screen shots beg for a CD-ROM version of the book. Unlike the O'Donnell and Winger book, Thomas's prose is pretty dry.

Clearly, the stronger book is *The World Wide Web for Scientists and Engineers* because of its emphasis on the Web. With the Web now the dominant Internet resource, the decision to devote only the last quarter of *The Internet for Scientists* to the Web makes the book an anachronism less than a year after publication. In fact, both books suffer from this problem. The Internet is a rapidly changing environment, and any printed book will quickly become outdated. For example, both books discuss the use only of Netscape Navigator (and, in *The Internet for Scientists*, version 2 at that!). Thomas opts not to discuss Microsoft's Internet Explorer because of its small market share, a situation that has decidedly changed, while O'Donnell and Winger omit it for political reasons—they feel that Bill Gates is wealthy enough, an opinion I am sure keeps Gates awake at night.

For those starting to author on the Web, *The World Wide Web for Scientists and Engineers* is a fine primer. True novices will find *The Internet for Scientists* of some use. But anyone who has spent some time on the Web will probably have already bookmarked free sites covering these topics and will find little to justify the acquisition of yet more paper.

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The Quantum Beat: The Physical Principles of Atomic Clocks

Fouad G. Major
Springer-Verlag, New York, 1998.
475 pp. $49.95 hc
ISBN 0-387-98301-5

Throughout history, the precision of clocks was an indicator of the level of a society's technological development. Furthermore, precision clocks and their use connected the then state-of-the-art of science with the ability to exploit technology for major national goals. This was true for the "clockwork of the heavens" that governed ancient Egyptians, the conquests of the Arabs and the discoveries of early European explorers, as it was true for the chronometers that were essential for the exploits of Captain James Cook, and as it is true today for global navigation and the preeminence of US military capabilities.

Even more interesting to the physicist, perhaps, is the fact that the development of atomic clocks was inseparably intertwined with advances in spectroscopy. Who doesn't know the Stern–Gerlach experiment? Who hasn't heard of I. I. Rabi or Charles Townes? More recently, Hans Dehmelt, Wolfgang Pauli and Norman Ramsey received the 1989 Nobel Prize in Physics for their work on atomic beams and ion traps, which are at the core of today's atomic clocks. Even more recently, the 1997 Nobel Prize in Physics was awarded to Steven Chu, William Phillips and Claude Cohen-Tannoudji for their work on trapping and cooling atoms, work that may lead to a next generation of atomic clocks with precision in excess of 10^{-18}.

Fouad G. Major captures this excitement in his very impressive but slightly flawed (see below) book *The Quantum Beat: The Physical Principles of Atomic Clocks*. He begins with a description of celestial and mechanical clocks and ends with laser cooling of atoms. On this road, which takes him from prehistoric times to speculation about tomorrow's feats in physics and technology, Major's stops include quartz clocks, today's atomic clocks and trapped ion systems, as well as resonance-stabilized lasers.

The author's several decades of association with the field include developing NASA's mercury ion frequency standard. The authenticity of the book is enhanced by the author's close connection with leading physicists who were willing to review the text; they include Nobel laureates Ramsey and Cohen-Tannoudji, as well as Claude Audoin, who authored (together with Jacques Vanier) the most comprehensive and in-depth treatment available today of atomic clocks, *The Quantum Physics of Atomic Frequency Standards* (Institute of Physics, 1989).

The author claims that he wrote his book for nonspecialists with some knowledge of physics or engineering. He achieves this objective as far as the core portions of the book are concerned; most notably, this includes the chapters on clocks (mechanical, quartz, rubidium, cesium, hydrogen, lasers and, finally, trapping and cooling of ions and atoms). Using historical developments as his primary ordering principle, Major focuses correctly and instructively first on the discovery and use of periodic phenomena such as the day and the year, then on oscillators and, finally, in the heart and soul of his book, the quest for spectroscopy of atoms at rest, unperturbed in free space. The degree to which this ideal is approximated governs the accuracy and precision of the atomic clock, which today, with commercially produced devices, range between 10^{-11} and 10^{-14}. Just to remind the reader, 10^{-14} corresponds to timekeeping of 1 ns per day, and 1 ns translates into one foot positioning using electronic means—that is, distance determination through clocking the propagation of electromagnetic signals, which, as we all know, occur with the speed of light.

In view of this expert treatment of the core features of the book, it is somewhat disappointing to read the interspersed excursions into the fundamentals of engineering and physics. The reader is treated to the wave equation, Fourier analysis, the Schrödinger equation and the atom model, all subjects where the author's otherwise splendidly achieved avoidance of mathematics is reversed and equations are the explanation. Worse, these sections, which are not needed for the core sections, break the flow of thought and disengage, rather than engage, the curious reader.

In addition, two chapters give an unnecessarily detailed treatment to two relatively unimportant subjects: chapter 13 on the NASA mercury ion experiment and most of Chapter 10 on the ammonia maser. The former is obviously there because of the author's personal contributions; the latter is justified, in principle, by the historical significance of the ammonia maser as the first working quantum oscillator, but the account of physical and engineering detail is quite irrelevant to existing and future atomic clocks.

Finally, the book misses some excitement stemming from the role of atomic clocks and crystal oscillators as key drivers in the evolving global navigation and communication applications. From recreational use for locating and communicating to the decisive military advantage exploited by the US and its allies in the 1991 Persian Gulf War, from the control of electric power and fleets of trucks to the locator map in automobiles to high-speed digital data transfer, an increasing number of specialized as well as broad societal uses depend on this technology. The book does discuss the Global Positioning System, but even there fails to touch on differential GPS and most of GPS's key applications.

Nevertheless, the book is a welcome and valuable addition to this important field. As the author declares, it is for the nonspecialist but well-rounded physical technologist. The reader should have no hesitation in skipping whole chapters or subjects, especially those mentioned earlier. In doing so, the book becomes very accessible and will prove informative, stimulating and even enjoyable.

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Computational Physics

Nicholas J. Giordano
Prentice Hall, Upper Saddle River, N.J., 1997. 432 pp. $70.00 hc ISBN 0-13-367723-0

An Introduction to Computational Physics

Tao Pang
Cambridge U. P., New York, 1997. 374 pp. $85.00 hc ($39.95 pb) ISBN 0-521-48143-0 hc (0-521-48592-4 pb)

Computational Physics by Nicholas J. Giordano is an excellent introductory text for undergraduate physics students, taking them gently and systematically from a simple trajectory problem to advanced topics such as chaos, phase transitions and protein folding. In the process, Giordano covers all aspects of computational physics, including the stability and accuracy of numerical methods, programming style and, most important, the physics. This book stands out from the numerous other texts on this subject because it is written with a strong emphasis on the physics and not just as an introduction to numerical methods.

The first chapter lays a solid foundation for even the most elementary physics student. Giordano begins the book by introducing the concept of finite-difference approximations using the very simple problem of radioactive decay. After explaining the essentials of writing a working program, he uses this example to raise such important issues as code testing, programming style and presentation of the results. This comprehensive approach is maintained throughout the book, with particular emphasis on numerical accuracy. In chapter 3, Giordano illustrates the importance of numerical stability in a practical manner by leading the student through a simple pendulum problem using the Euler method (this approach produces a nonphysical answer).

Computational Physics is presented at a level that is perfectly suited for a course between the standard first-year physics course and advanced undergraduate physics courses. In addition to learning computational physics, students will get a reinforcement of first-year physics as well as a chance to extend their physics knowledge to problems closer to home. For example,