

slightly short chapter to what is perhaps his most widely recognized work: the field of small-world networks. The prime example is known as “six degrees of separation,” which refers to the parlor game in which one tries to link a given actor to a target (historically actor Kevin Bacon) through the smallest chain of movies sharing common costars. Strogatz describes how small-world networks are intermediate between regular and random networks. A few shortcuts that link random points in a regular network have a drastic effect on the connectivity: The average path length goes down significantly, while the local order in the network is hardly affected. Small-world networks have been found in numerous situations, such as in the nervous system of the worm *C. elegans*, the US power grid, and the Internet. But their influence is not always benign: Viruses and epidemics, for example, can easily spread globally.

*Sync* is one of those rare books that can profitably be read and enjoyed by both experts and laypeople. It comes with a very complete set of notes that provide detailed literature citations and technical comments. The book could even serve as an excellent reading assignment for an introductory course on complexity. So go read *Sync*. And if you like it, tell all your friends about it.

On second thought, don't bother. I already have.

## The Discovery of Global Warming

Spencer R. Weart  
Harvard U. Press, Cambridge,  
MA, 2003. \$24.95 (228 pp.). ISBN  
0-674-01157-0

Two mountain villages, one Swiss and the other French, are neighbors and only a few miles apart. What divides the communities is the snowy roof mass of Mont Blanc, western Europe's highest mountain, in the French Alps; so visits between the villages are uncommon. But during the 18th century, as Spencer Weart recounts in *The Discovery of Global Warming*, both settlements were eager to share experiences when they saw the coarse, glacial ice sheet—always a grim sight for the towns—slowly move nearer their homes.

The elders recalled from village lore how disappointed the people were when their rare exchanges disclosed the threat to every visible wall of shel-

ter on both sides of the mountain. The ice ignored every human appeal, even prayer; only patience and hope offered a defense. The climate was changing, not merely the weather. Climate includes the locally expected weather, such as the valley heat or mountain snow. That a reliable climate also can change may sound like a paradox: Isn't climate the steady part of changing weather?

Global warming is a worldwide summertime and an unexpected discovery. Of course, ice ages have long belied a fixed climate. At least several millennia ago, mountainous ice caps gripped the world through several cycles. Climate itself has gone through profound, repeated change.

Ice ages have long been recognized as cosmic phenomena caused by interplanetary gravitational interactions that transform any simple elliptical orbit like Earth's into rosettes. A well-verified astronomical dance creates small but long-lasting deviations in the distance between Earth and the Sun. Sunshine that hits Earth dims and brightens time and time again. The deviations correspond with the main classical epochs of ice-age glaciation. Astronomical in origin, this climate-change puzzle was solved by means that depend on the effects of times and distances so great as to be irrelevant to everyday weather.

Detailed facts about global warming can be found in countless research tables, graphs, maps, and other such records. Yet *The Discovery of Global Warming*, a thorough history of the subject, has only four graphics in more than 200 pages. But those few graphics are compelling. First, the data in the book stamp a vivid label on one variable: the abundance of carbon dioxide. The large variations in levels of carbon dioxide, which is found in only a few parts in 10 000 of Earth's atmosphere, are strikingly coherent. The data reveal changes in carbon dioxide content in Antarctic air measured at different locations over almost 50 years. One set of data show, in two years, continent-wide variations of carbon-dioxide levels, from Antarctica's icy coast to its far-off South Pole station. Another graph records carbon-dioxide levels from 1958 to 2002 at the high Hawaiian plateau of Mauna Loa. Each year resolves a repeated seasonal rise and fall, with an overall change of 30% in levels of the gas.

Weart is the director of the Center

for History of Physics at the American Institute of Physics. His deep engagement with the history of physics informs the book's guiding summaries of the climate pioneers: Benjamin Franklin, Joseph Fourier, John Tyndall, Svante Arrhenius, John Von Neumann, and Guy Callendar. It was Callendar, an engineer, who cut right to the chase in his 1938 paper to the Royal Meteorological Society about the causes of climate change so decisive in our own history. Callendar advanced data to support his argument that human-made fires in the 20th century generated sufficient amounts of carbon dioxide to raise global surface temperatures. Callendar's research introduced reasons behind global warming but did not bring clarity to the events overall.

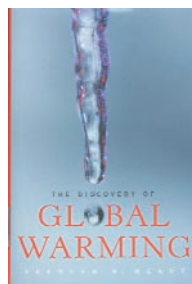
Halfway into the book's history on global warming, Weart presents a plot of surface temperatures around the world. Described in the book as “the first entirely solid and comprehensive global analysis of average surface temperatures,” the graph reveals a dozen big peaks from global temperature records from 1880 to 1980. The warmest three

years, according to a 1986 study of a 134-year record, had all occurred in the 1980s. But cooler weather was what most people recalled during the first years of the warming period.

The disparate details of the climate problem set a tough course for the public. Weart's figure 3 is a graph that, although somewhat marred by scientists' reconstruction of old temperatures, documents a swift, strong, credible upturn from the circumstances of the last century. Familiar instruments and complete, meticulous records were valuable to climate scientists and helped bolster their credibility as “the greenhouse gases and the temperature soared.”

The next pages of the book include a metaphor so apt that it seems all but unfair to debate it: “The global climate system,” said geochemist Wallace Broecker in the 1990s, “is an erratic beast, and we are poking it about with a sharp stick.” Insightful and eloquent, Broecker had introduced in his own doctoral thesis 30 years earlier a bold proposition for rapid climate change.

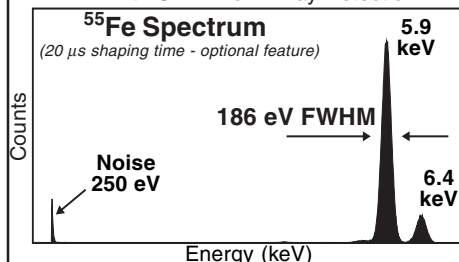
The closing paragraph in Weart's book sums up the public struggle with the unprecedented changes of climate—changes supported by a rapid increase, from 1900 on, of data, memories, and forecasts from researchers.



# X-Ray and Gamma Ray Detectors

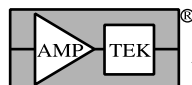
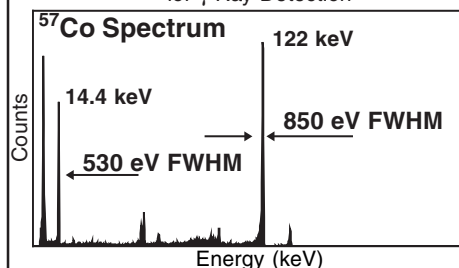
## XR-100CR

With Si-PIN for X-Ray Detection



## XR-100T-CdTe

With Cadmium Telluride (CdTe)  
for  $\gamma$ -Ray Detection



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XR-100CR X-Ray Detector and Power Supply shown with Amptek MCA8000A 'Pocket MCA' and a laptop computer.

### APPLICATIONS

- Fluorescence
- OEM
- Process Control
- Environmental Monitors
- Nuclear Medicine
- Lead Detectors
- X-Ray Tube Beam Monitor
- Nuclear Plant Monitors
- Vacuum Applications
- Portable Instruments
- Semiconductor Processing
- Sulfur in Oil & Coal Detection
- Plastic & Metal Separation
- Nuclear Safeguards Verification
- Space & Astronomy
- Teaching and R&D
- Art & Archaeology

Circle number 34 on Reader Service Card

Figure 3, first published in 1999, is called a "hockey stick" because of the plot's dramatic upward slope recorded at the very end of the 20th century. The evidence Weart provides has convinced this initially doubtful reviewer of the causes behind global warming. Let us cite Weart's own words found on the final page of his book, which call upon all of humanity to act:

Much more likely than not, global warming is upon us. We should expect weather patterns to continue to change and the seas to continue to rise, in an ever worsening pattern, in our lifetimes and on into our grandchildren's. The question has graduated from the scientific community: climate change is a major social, economic, and political issue. Nearly everyone in the world will need to adjust. It will be hardest for the poorer groups and nations among us, but nobody is exempt.

**Philip Morrison**

Massachusetts Institute of Technology  
Cambridge

## Numerical and Analytical Methods for Scientists and Engineers Using Mathematica

Daniel Dubin

Wiley, Hoboken, NJ, 2003.

\$120.00 (633 pp.). ISBN 0-471-26610-8, CD-ROM

Like Daniel Dubin, author of *Numerical and Analytical Methods for Scientists and Engineers Using Mathematica*, I find myself using this technical computing software nearly every day to perform routine mathematical drudgery, such as analytical differentiation, integration, and series summation. I also employ *Mathematica* as a sophisticated graphical tool. I was therefore interested to see how Dubin would use the program to teach mathematics.

In the preface, addressed to the student, he explains how the book was developed from lecture courses aimed at

advanced undergraduates and graduates studying the physical sciences or engineering. His informal style, generally clear and concise, is continued throughout the book and will probably be appreciated by the intended audience. Extensive exercises that appear at regular intervals in the text also clearly mark Dubin's work as a textbook.

Although the title appears more general, the motivation and focus of this book from start to finish is solving differential equations. The emphasis is clear from the table of contents: Five of the eight chapters have the words "differential equations" in their titles. The other three chapters, on Fourier series and transforms, eigenmode analysis, and random processes, are also inspired by applications that involve solving differential equations. The coverage of methods for solving both ordinary and partial differential equations probably extends well beyond most introductory courses, and thus the book is a potentially useful reference for research applications. An introductory chapter with references to other textbooks and online collections of numerical software might have been helpful, because those sources are likely to be the best places to turn for additional information—or when *Mathematica* runs out of steam and specialized programs are needed.

The book assumes that readers have already had introductory courses in calculus. From the very beginning, the text presents *Mathematica* program examples and exercises. Accompanying the book is a CD-ROM featuring a supplementary chapter with a useful guide that includes the most commonly used *Mathematica* routines and exercises, plus an explanation of potential error messages. Readers who are new to the program should work through this chapter first.

The entire book is also on the accompanying CD-ROM, which enables readers to come to grips with the content first hand and should be especially valuable to students. Working examples that can be adapted for related problems of particular interest will help readers to avoid the frustration that may result from making common syntactical mistakes. Examples include a wide range of standard problems from physics and engineering, such as initial- and bound-

ary-value problems involving the Poisson, wave, Schrödinger, heat, diffusion, Fokker-Planck, and Laplace equations and problems concerning geometric optics.

