

ingly awkward organization. In particular, some theoretical details are delayed until later chapters on applications. For example, a student introduced to the fundamentals of absorption in chapter 4 might logically proceed to single-line transmission and band models (including k -distributions), rather than postponing the discussion until chapter 10. Other organizational difficulties include the apparent lack of a unifying theme in chapters 5 and 6 (somewhat abstractly titled "Principles of Radiative Transfer" and "Formulation of Radiative Transfer Problems," respectively). Topics in chapter 5 range from the definition of bidirectional reflectance to the radiative transfer equation solution in the absence of scattering; topics in chapter 6 range from scaling transformations for anisotropic scattering to the principle of reciprocity.

Another concern is notation. The authors follow the uncommon conventions of H. C. van de Hulst (*Multiple Light Scattering*, Academic, 1980), but they also make unorthodox choices for subscripts and superscripts (for example, the direct solar beam is indicated with a superscript s , although the corresponding angles use the common subscript 0 notation). Especially disconcerting is the common notation shared by numerous reflection and transmission functions, whose meanings (and units) depend on the arguments.

We had mixed feelings about the problem sets. They are more extensive than in previous texts but are often too challenging without adding much insight. More introductory problems would have been helpful.

All in all, this is a valuable resource for those interested in terrestrial radiative transfer. It contains good discussions and physical explanations within the main text, useful summaries, notes, comments, and up-to-date references. Prospective instructors should be aware that the extensive amount of material in the book makes it appropriate for a two-semester course.

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The Diamond Makers

Robert M. Hazen

Cambridge U. P., New York, 1999.

244 pp. \$15.95 pb

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People have treasured diamonds for thousands of years because of their unrivaled hardness and their brilliance

as jewels. When early chemists (1797) found that diamond is a crystalline form of pure elemental carbon they, along with physicists, engineers, and various kinds of experimenters, tried to make diamond from cheaper, baser forms of carbon or carbon compounds.

Robert Hazen's *The Diamond Makers*, is a compelling, nontechnical narrative covering centuries of history related to diamond, centered mostly around brilliant, often eccentric and controversial pioneers of research at high pressures. Success at diamond synthesis did not come until the science of thermodynamics in chemistry and physics had developed to the degree that it could indicate the parameters of possible reaction paths. Further, new geometries and construction materials had to be developed to make possible high-pressure apparatus capable of simultaneously generating and holding pressures and temperatures higher than had ever been achieved before. The chemical-physical reaction condition also proved to be quite subtle. Although dozens of scientific articles and reports, on the subject were published during the 19th and 20th centuries, *The Diamond Makers* is the first major publication to cover the whole period from the human point of view, while maintaining scientific integrity.

Hazen is well qualified in many respects to write this book. He is an active scientist at the Geophysical Laboratory of the Carnegie Institution of Washington. For many years, as a side activity, he has written books for young people and the general public portraying the excitement and the human side of scientific research. For example, his 1988 book *The Breakthrough*, (Summit), is a thrilling account of the race to find, develop, and understand higher-temperature superconductors. It is written in a style that has the drama and suspense of a murder mystery, yet is true to the science.

In *The Diamond Makers*, Hazen gives a thorough and exciting account of the history of diamonds and the efforts to synthesize them. Many famous scientists and engineers took their turns at trying to make diamond from baser forms of carbon. Final reproducible success was not attained until the 1950s, after scientists had developed adequate thermodynamic understanding, the high-pressure-high-temperature apparatus, and the reaction path needed. Much human drama was involved.

In preparation for writing the book, Hazen did a thorough job of

studying the relevant scientific literature, and he interviewed personally those still living who had been involved in the diamond-making story. From the interviewees, besides their own stories, he drew much recollected information about their predecessors. As one of the surviving diamond-makers, I am able to vouch for the thorough and open-minded interviews Hazen conducted.

In 1951, I was the first of the General Electric Research Laboratory scientists to be assigned to the problem of diamond synthesis. My target was the theory of reaction paths within thermodynamically stable conditions. After the first reproducible successful synthesis by team member H. Tracy Hall in late 1954, I continued for 30 years to help to establish experimentally the pressure-temperature phase diagram of carbon. I also helped to develop apparatus and techniques to extend the range of laboratory high-pressure research to about 70 gigapascals (~700 000 atm) and high-temperature parameters to the 2.5 K-to-6000 K range.

The book begins by treating the situation as it was in prehistoric times, when people had learned by experience much about materials found in nature and how they could be shaped and used effectively. One of the ancient artisan's "secrets" was that different kinds of stone could be arranged in a hierarchy of hardness, and the harder ones could be used to shape or dress the softer ones. Of all the kinds of stones, diamond was the hardest and could be used to work the hardest of other stones. Such diamond tool-stones were rare, highly prized, and carefully guarded by ancient artisans.

The major part of the book is devoted to portraying the people and teams of people who worked toward the actual synthesis of diamond, and the interactions and rivalries that existed among them. In addition to the successful high-pressure-temperature, catalyst-solvent process, which is used worldwide today to produce nearly all synthesized industrial diamond, later chapters in the book cover two other developments: an explosive shock-compression process that converts a dispersion of graphite particles in suitable thermal quenching media into fine-grained diamond powder, and a low-pressure chemical vapor deposition (CVD) process, carried out under thermodynamically unstable conditions that can produce films or thin plates of crystalline diamond carbon on selected substrates. The last part of the book deals with efforts of scientists

to harness the remarkable physical properties of diamond in miniature ultrahigh-pressure apparatuses (diamond anvil cells), using opposing, single-crystal diamond anvils to generate extremely high pressures in very small regions—pressures nearly as great as that at the center of planet Earth (about 3.5 megabar).

Today hundreds of scientists, in dozens of laboratories around the world, use apparatus and techniques that descended from those developed for diamond synthesis efforts of earlier decades. High-pressure, high-temperature techniques in scientific studies are more in use today than ever before in history. *The Diamond Makers* tells us how we got there.

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Nonclassical Physics: Beyond Newton's View

Randy Harris
Addison-Wesley, Menlo Park, Calif., 1999. 608 pp. \$95.00 hc
ISBN 0-201-83436-7

By calling his book *Nonclassical Physics: Beyond Newton's View*, Randy Harris avoids the term "modern physics." This is not a bad idea, since the term refers to physics developed mostly in the first half of the 20th century. Nevertheless, this is a textbook intended for the traditional undergraduate modern-physics course.

Harris begins his book with a lengthy chapter on relativity. He then examines wave-particle duality, with one chapter on light behaving as particles and another on particles behaving as waves. The heart of the book is four chapters of conventional introduction to Schrödinger's wave mechanics, with applications to atomic physics. Then, after a chapter on statistical mechanics, he concludes with chapters on solid-state physics, nuclear physics, and fundamental particles and interactions.

A text on modern physics has several tasks to perform. It should introduce students to phenomena and experiments that inspired the creation of quantum mechanics. It should also stimulate student interest in contemporary physics and show its impact on present-day technology. Because of a widespread sense that it is urgent for students to become familiar with quantum theory early in the undergraduate curriculum, a text on modern physics increasingly has to

introduce the concepts and formalism of quantum mechanics. This means students need to deal with complex numbers and the solution of ordinary and partial differential equations earlier than they ordinarily would. They also need to explore in a thoughtful way the strange consequences of linearity and superposition.

How successful is this book at these tasks? It does a creditable job of introducing basic quantum mechanics up through the solution of the Schrödinger equation for the hydrogen atom. The treatment of a particle interacting

with various step and barrier potentials struck me as particularly clear and direct. But the author's claim that his book supplies the necessary math (mostly in an appendix) is unconvincing. Students with whom I deal go glassy-eyed unless some considerable time is spent accustoming them to complex exponentials, the harmonic oscillator differential equation, and separation of variables.

The book needs to give more attention to important concepts of quantum mechanics. Although there are explanations of why the wavefunction is

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