

Nano-Hype: The Truth Behind the Nanotechnology Buzz and The Nanotech Pioneers: Where Are They Taking Us?

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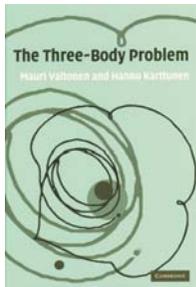
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The image shows a Lake Shore Cryotronics M91 FastHall Controller. It is a rectangular, silver-colored device with a large color touchscreen on the front. The screen displays four measurement panels: 'Continuity' (Not run), 'Contact Check' (2019-01-01 at 01:59, 2007 ms), 'Resistivity' (2019-01-01 at 01:59, 1058 ms), and 'FastHall™' (with a circular progress indicator). The device has a 'Lake Shore CRYOTRONICS' logo on the top left and 'M Measure Ready M91 FastHall' on the bottom right. To the right of the device, the text 'Measure Ready M91 FastHall™ Controller' is displayed in white and orange, followed by the tagline 'A revolutionary new instrument for complete Hall analysis'. The Lake Shore Cryotronics logo is also present in the bottom right corner of the advertisement.

applications of an issue central to basic physics. In the late 1600s, Isaac Newton tested gravity among three massive bodies by studying the Moon's motion in the combined field of Earth and the Sun. But it was only in 1878 that astronomer George W. Hill found a method yielding results that matched the ancient Greek observations.



some careful formal development. Valtonen and Karttunen have carefully written down every step in the arithmetic and included helpful diagrams. Each chapter ends with problems, some involving numbers from astronomy.

The authors' main achievement is their coverage in the last five chapters of the many

different applications in astrophysics in which one of the three bodies is much lighter than the other two. Those applications are based on an unperturbed two-body system that rotates in a fixed plane. A rotating reference system for the third body then becomes most natural and introduces a Coriolis force, in addition to the gravitational field. This feature causes all kinds of marvelous things to happen, like the neighborhood of the Lagrangian points, where the third body can remain at rest. Depending on the initial condition, however, the third body can scatter and thus change the orbital elements of the two heavy bodies. There is a whole catalog of disasters, such as capture, exchange, flyby, collision, and even ionization, that are important to comets from the Oort cloud. The authors describe such phenomena with approximate arguments and numerical results.

Three-body problems are also fundamental in atomic and high-energy physics. The negative hydrogen ion, which consists of one proton and two electrons, determines the Sun's surface temperature to be 6000 K; we here on Earth can count on an average temperature of about 300 K. The proton consists of three quarks, and yet its magnetic moment is still not adequately explained. Overall, three-body problems are important but difficult to understand.

Valtonen and Karttunen work at the Väisälä Institute for Space Physics and Astronomy at the University of Turku in Finland. Their introduction offers a long and surprising list of examples from modern astrophysics, all based on classical mechanics. Except in the book's final chapter, the three bodies are treated as point particles, where the mass is concentrated in a mathematical point without such further properties as angular momentum. The systems without a stable configuration are emphasized—for example, an asteroid whose motion is determined by the Sun and Jupiter. In the first five chapters, the authors provide a classical mechanics course that goes well beyond the ordinary graduate textbooks.

The Kepler motion, including the hyperbolic trajectories, is the necessary starting point. But three-body systems have four degrees of freedom that cannot easily be separated by a canonical transformation, so one cannot avoid

In the last chapter, Valtonen and Karttunen step outside the solar system and consider three bodies of comparable mass, but with known volumes like our nearest neighbor in space, Alpha Centauri, where all bodies are self-sustaining stars. Slow or fast three-body encounters with more or less dramatic consequences may exist. Sometimes those encounters resemble phenomena in atomic and molecular physics or even nuclear and particle physics. Although the chapter's title, "Some Astrophysical Problems," sounds innocent, it starts immediately with a section on binary black holes in the cen-

ters of galaxies. The reader now advances to the post-Newtonian formalism, which includes the effect of gravitational radiation. The mathematics is greatly simplified, and the arguments are kept within the bounds of reasonable models without undue speculations. The reader gets involved in whole galaxies colliding and melting together so that individual stars find binary companions for life. The chapter concludes with comets—fuzzy balls on a haphazard journey through the solar system.

In *The Three-Body Problem*, readers will find the necessary theoretical ingredients and will also enjoy the great variety of technical explanations for phenomena in the solar system and beyond. The book would be useful for a graduate course in modern astrophysics and makes interesting reading for an amateur who has some background in classical mechanics.

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New York City

Nano-Hype

The Truth Behind the Nanotechnology Buzz

David M. Berube
Prometheus Books, Amherst, NY,
2006. \$28.00 (521 pp.).
ISBN 978-1-59102-351-7

The Nanotech Pioneers

Where Are They Taking Us?

Steven A. Edwards
Wiley-VCH, Weinheim, Germany,
2006. \$32.50 (244 pp.).
ISBN 978-3-527-31290-0

Nanotechnology has entered today's general discourse. This trend has provided an opportunity for society, particularly its young people, to learn

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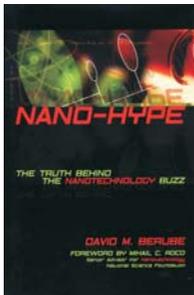


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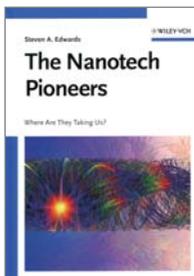
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about and appreciate technology's role in maintaining the nation's polity and economy. Previous books such as *The Dance of Molecules: How Nanotechnology Is Changing Our Lives* (Thunder's Mouth Press, 2006) by Ted

Sargent; *Nanotechnology: A Gentle Introduction to the Next Big Idea* (Prentice Hall, 2003), which I cowrote with my son Daniel Ratner; and *Understanding Nanotechnology: From the Editors of "Scientific American"* (Warner, 2002) have attempted to describe and discuss nanotechnology for nonspecialists. David M. Berube's *Nano-Hype: The Truth Behind the Nanotechnology Buzz* and Steven A. Edwards's *The Nanotech Pioneers: Where Are They Taking Us?* offer very different viewpoints in an attempt to cover some of the same ground.



Berube, a professor of communication studies at the University of South Carolina in Columbia, has done extensive homework for his book: It has 521 pages of text, including 105 pages of footnotes and 36

pages of bibliography. According to the book's blurb, the author "investigates the gossip and rumors and reveals the underlying motives of the hypesters and pitchmasters." Much of the text consists of direct quotes, including some reasonable and accurate ones. For example, Berube cites Mihail Roco, senior adviser for nanotechnology at NSF. Roco emphasizes that the inclusion of social scientists and humanistic scholars is important to the National Nanotechnology Initiative: "They are professionally trained representatives of the public interest and capable of functioning as communicators between nanotechnologists and the public or government officials. Their input may help maximize the societal benefits of the technology while reducing the possibility of debilitating public controversies" (page 311).

Yet among such careful thoughts are many pages of inflated prose and claims, often without distinction, that Berube has filtered from the broad literature on nanotechnology. A lot of hype is indeed out there, so the topic of choice for his book is good—but the product is not. The publishers have apparently done little if any editing; the book is full of misspellings, terrible

grammar, and inaccuracies. For example, the author's statement on page 41 that "nanotechnology is not only something we can't see but also something that isn't here yet" is seriously wrong, given the existence of major industrial processes such as giant magnetoresistance drives and zeolite catalysis for high-octane gasoline and many specific nanoproducts. Similarly, his remark on page 289 that carbon nanotubes are "being produced at a greater rate than other nanoparticles" is incorrect, as is clear from Berube's comment 10 pages later that the Illinois-based Nanophase

Technologies Corp shipped more than 450 tons of zinc oxide nanoparticles in 2002.

Worse than those simple errors is the level of repetition and confusion in many sentences: "Once again, the action devolves to uncontrolled replication when the issue is corporate concentration, the antecedent to their claims" (page 268); and "Only an audience with a sophisticated understanding of the subject and the argumentative subterfuge can be persuaded by the denials based in reality against the fictitious assumptions of the opposition" (page 275).

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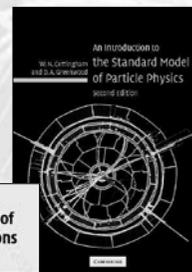
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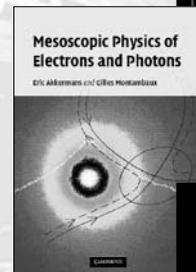
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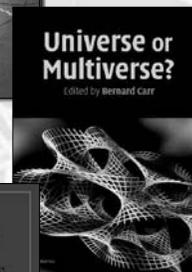
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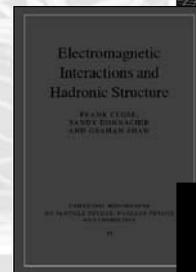
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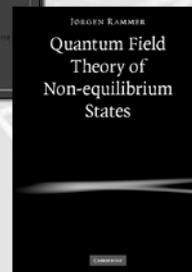
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Nevertheless, Berube has some good ideas and addresses some important issues. For example, he covers societal and ethical implications as well as government initiatives and actors. Had his book been better edited, it might have been a useful contribution to the literature on nanotechnology, although from a specific point of view that focuses on inflated claims.

The Nanotech Pioneers by Edwards, who is a medical-technology analyst and science writer with a doctorate in biology, is better because it is shorter and has financial figures and creative illustrations. It provides an appropriate overview of many areas of interest and contains some relevant history and descriptions of some commercial advances. It even discusses a bit of the same hype that Berube documents.

But, like Berube's book, the lack of editing is destructive. The first eight pages of chapter 1 contain five errors, ranging from a statement that is both factually and grammatically incorrect—"nanotech seeks to rebuild the world one molecule (or even one atom) a time"—to incorrect descriptions about the bonding in graphite and in diamond. On page 36 the author describes the birth of the National Nanotechnology Initiative and misspells van der Waals forces and the names of Paul Alivisatos and James Murday. In addition, Edwards makes several technical and historical errors. For example, the silicon from which chips are made is not analogous to the stone in lithography (page 41), nor did Erwin Schrödinger become famous for his uncertainty principle (page 44). Also, the level of tunneling current is not directly proportional to the distance between scanning tip and surface (page 57).

Such editing errors make the book much more difficult to read and can confuse nonscientists. In addition, the author's topic choices are questionable. Although the book claims to be about nanotech pioneers, with pages and pages on Bill Joy and Ray Kurzweil, the names of Sam Stupp and Alan Heeger—true nanotech pioneers—are not mentioned. Lots of information is discussed from the first chapter to the last, including the gray- and green-goo scenarios in which nanobots or bioengineered life forms run amok and take over the world. But the author does not discuss such challenging and promising nanotechnology advances as regenerative medicine or custom coatings.

The books by Berube and Edwards discuss a timely and interesting topic. But for each, a well-edited second edi-

tion might help a lot. In the interim, better analysis of nanotechnology is out there. More scientists and engineers should take up the challenge of writing it right. It is important for the public and private sectors to understand the ideas and challenges behind nanotechnology; unfortunately, *Nano-Hype* and *The Nanotech Pioneers* may do more to add to the confusion than to clarify the concepts, applications, and people involved.

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Introduction to Computational Science Modeling and Simulation for the Sciences

Angela B. Shiflet and George W. Shiflet
Princeton U. Press, Princeton, NJ,
2006. \$69.50 (554 pp.).
ISBN 978-0-691-12565-7

Computational science is a relatively new field, but it has conquered the scientific world quickly and now offers a valuable tool set for today's researchers. Without its modeling and simulation applications, modern physics, chemistry, and biology would not exist. *Introduction to Computational Science: Modeling and Simulation for the Sciences* by Angela Shiflet and George Shiflet, a wife-and-husband team, aims to be a comprehensive, basic text for beginning students of computational science.

The book's strength is that almost from the first page it lets the reader do the science. Soon after the short theoretical introduction, readers have made their first computational model using their chosen model-building and simulation software.

Angela Shiflet is chair of the department of computer science, and George Shiflet is chair of the department of biology, both at Wofford College in South Carolina. They have been smart enough not to pick a specific software package; instead, they offer an accompanying website where readers can access software-specific content for the models presented in the book. This approach allows the authors to keep their book

up to date, which is a must in this rapidly evolving field.

The book supports common software packages such as STELLA, Vensim, and even Excel, which makes it easy for the beginner. The text treats two main computational methods: system dynamics, which is based on numerical integration of first-order differential equations, and cellular automata for modeling spatially distributed phenomena. The authors discuss other techniques like Monte Carlo simulation and data-driven analysis in less detail.

Introduction to Computational Science delves right into the basic concepts of the field—from computer representation of numbers to the basics of difference and differential equations to system dynamics and Euler integration. Sometimes I thought that the level may be a little too low for undergraduates enrolled in a computational science course, as most will already have some mathematical background. But luckily, the book does not stop at the basics: It eventually succeeds in bringing students to a reasonably advanced level. Let me reassure those who fear that computational science is not for them because they are not programmers: The book does not contain a single line of programming code, unlike other similar texts such as *An Introduction to Computational Physics* (Cambridge U. Press, 1997) by Tao Pang and *Introduction to Computational Science and Mathematics* (Jones and Bartlett, 1996) by Charles F. Van Loan. Using today's software, one can learn the basics without having to program.

I was impressed by the number of student projects the book offers. Newtonian mechanics, population dynamics, the spreading of diseases and fires—they are all present. Each project follows a fixed pattern: After a short introduction, students have the task of creating a model for simulating the systems that are presented. So, apart from learning about computer modeling, they can also extend their scope of knowledge about the subject under analysis. It is interesting to see how, with relatively simple building blocks, one can really get into many domains using computational science. Students may think they can easily come to grips with unknown territory using the newly acquired software tools offered in the book, but such an assumption may be misleading in some cases where a greater knowledge of programming is required.

The book's weak part is in the chapter on high-performance computing.

