

colleagues. He also recounts instances of his attendance at key meetings where crucial decisions were made. On the evening of 4 October 1957, he was present at the Soviet Union's embassy in Washington, DC, when the electrifying news of the *Sputnik* launch was shouted out. He was a graduate student then, but attended as the designated alternate to Van Allen, who was out of the country at the time.

It was a pleasure to work with George and to review *Opening Space Research*, a welcome addition to the historical literature documenting the genesis of US space exploration.

Henry Richter
Escondido, California

Physics of the Future

How Science Will Shape Human Destiny and Our Daily Lives by the Year 2100

Michio Kaku
Doubleday, New York, 2011. \$28.95
(389 pp.). ISBN 978-0-385-53080-4

Michio Kaku's latest book, *Physics of the Future: How Science Will Shape Human Destiny and Our Daily Lives by the Year 2100*, is based on an appealing premise: Since the laws of physics are not likely to change between now and 2100, they can provide insight into how our world will. Kaku explores this observation through interviews with "more than 300 of the world's top scientists, thinkers, and dreamers," who are asked to base their forecasts on technologies that exist at least in prototype form today.

The result, alas, is a kind of future by committee. We're told that in the future there will be real-time spoken language translators; in the present there's an app for that. The book ends with a scenario of a day in the life in 2100 that features such science-fiction staples as magnetically levitating (maglev) cars, wrist-watch videos, space elevators, and artificial-intelligence avatars. Such a forecast could have been accomplished with less effort by collating covers from popular science magazines.

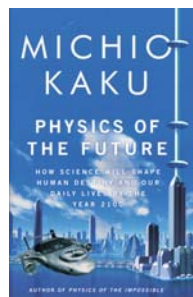
This future also appears to ignore important ideas introduced earlier in the book. A city dump overflows with electronic chips and robot parts, but research on digital materials argues strongly for a future in which functional systems are disassembled and reused rather than disposed. In 2100 one regularly shops for robot models,

but current research on programmable matter suggests that actuation will be distributed, reconfigurable, and integrated with computation rather than embodied in discrete devices. Worse, there are some surprising physics errors. The maglev driver observes that "you rarely need to fuel [the maglev vehicle] up, since there is almost no friction to slow it down." Unless the atmosphere is also superfluid in the future, air friction will be a significant loss mechanism at the velocities that would be hoped for a maglev vehicle.

Another problem with a future found from interviews is oversights based on who was interviewed for the book. Printed organic LEDs are introduced for electronic paper displays, but not the microencapsulated electrophoretic displays widely used in e-book readers. Electronic inks have the great virtue of modulating light as paper does, rather than having to generate light. Another section describes quantum computing in terms of superposition, which applies equally well to classical waves, but makes no mention of the essential roles of entanglement and projective measurement. Further on, the author describes the goal of creating life, but does not note the spectacular *ab initio* synthesis of a self-replicating bacterial cell, *Mycoplasma mycoides*. Metamaterials are not mentioned at all.

Asking technical evangelists about the future can also lead in *Physics of the Future* to uncritical reporting of what could be called "aspirational technologies" that are based on their descriptions rather than their physics. An "internet" contact lens is glowingly described for augmented reality, without discussion of the daunting challenge of controlling the phase or angle of light for the eye to be able to focus a source in such close proximity. The discussion of DNA computing omits explanations of the very limited scaling of brute-force combinatorial search or the slow diffusional time scales; the field has largely moved from universal computation to molecular programming for nanoassembly and medical applications.

The real strength of the book lies in its margins. The author makes an interesting observation that entropy would become the scarce resource in a world that can meet all of its energy needs with some combination of fusion and solar power: What happens if affluence buys order, and actions are judged by the disorder they create? Similarly,



what would life be like if a network of quantum repeaters allows entanglement to be shared as easily as we now share classical information? What if metamaterials succeed in decoupling our sensory experience from external reality? Such profound questions deserve a depth of attention to match. It would have been

more relevant to learn the author's perspective on these questions than to find out where and to whom he's presented lectures. Also, a few calculations, even in words, would have been welcome to illustrate how the physics works, as would some examples of the role of data-driven inference as a guide to forecasting.

Physics of the Future observes that "our destiny is to become like the gods we once worshiped." This follows from the evidence presented, if "god" is taken to mean "science fiction character." Although that's not such a bad fate, it's a projection with a great deal of prior art in science fiction. Perhaps the conclusion to draw about the future is that good storytelling remains a good way to do scenario planning for it.

Neil Gershenfeld
Massachusetts Institute of Technology
Cambridge

Single-Ion Solvation

Experimental and Theoretical Approaches to Elusive Thermodynamic Quantities

Philippe Hünenberger and Maria Reif
RSC, Cambridge, UK, 2011. \$144.99
(664 pp.). ISBN 978-1-84755-187-0

Classical thermodynamics is a beautiful subject. Albert Einstein famously said that it "is the only physical theory of universal content which I am convinced will never be overthrown." Indeed, scientists are confident that we will not observe any violation of the first and second laws of Rudolf Clausius's thermodynamics, even after we admit the post-Clausius realities of relativity, atomic structure, and quantum mechanics.

But other firm prescriptions of classical thermodynamics are not on such solid ground. For example, it is possible in the context of classical thermodynamics to measure the free energy of a solution containing sodium chloride, but because electroneutrality must be attained in bulk matter, it is impossible

APS CONGRESSIONAL SCIENCE FELLOWSHIP 2012-2013

THE AMERICAN PHYSICAL SOCIETY is currently accepting applications for the Congressional Science Fellowship Program. Fellows serve one year on the staff of a senator, representative or congressional committee. They are afforded an opportunity to learn the legislative process and explore science policy issues from the lawmakers' perspective. In turn, Fellows have the opportunity to lend scientific and technical expertise to public policy issues.

QUALIFICATIONS include a PhD or equivalent in physics or a closely related field, a strong interest in science and technology policy and, ideally, some experience in applying scientific knowledge toward the solution of societal problems. Fellows are required to be members of the APS.

TERM OF APPOINTMENT is one year, beginning in September of 2012 with participation in a two week orientation sponsored by AAAS. Fellows have considerable choice in congressional assignments.

A STIPEND is offered in addition to allowances for relocation, in-service travel, and health insurance premiums.

APPLICATION should consist of a letter of intent of no more than 2-pages, a 2-page resume: with one additional page for publications, and three letters of reference. Please see the APS website (<http://www.aps.org/policy/fellowships/congressional.cfm>) for detailed information on materials required for applying and other information on the program.

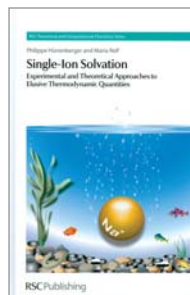
ALL APPLICATION MATERIALS MUST BE SUBMITTED ONLINE BY JANUARY 13, 2012.

to measure the free energy of a solution of sodium ions. However, single-ion thermodynamics becomes accessible when nonclassical techniques such as atomic and molecular spectroscopy are combined with statistical mechanics. In modern practice, quantum mechanical theory is often able to replace spectroscopic observations, and that also broadens the range of species that can be characterized thermodynamically.

Even though most scientists intuitively understand the breakdown of classical prohibitions, the technical issues surrounding the broadening of classical thermodynamics still engender controversy. For single-ion solvation, an ideal theoretical interpretation would include a free energy that reflects the interaction of a solute with an infinite solvent that has no boundary. But experimentalists inevitably measure a contribution associated with the electrical work of an ion crossing the dipolar vapor-liquid interface. Extrathermodynamic considerations, which may be either experimental or theoretical, are therefore required to estimate the surface term, and the estimates vary widely, by as much as 1 eV/ion (roughly 100 kJ/mol), with even the sign sometimes uncertain. Discussions of that surface effect can be confusing even to experts and can become heated (even though the effect itself is isothermal).

Single-Ion Solvation: Experimental and Theoretical Approaches to Elusive Thermodynamic Quantities by Philippe Hünenberger and Maria Reif offers the best discussion I've seen of the subject's complexities and subtleties. The book's careful explanations should make its readers much more comfortable in tackling the thorny issues; it can even make a previously confused person like me confident enough to write a book review. It is hard to overemphasize the high quality of the writing. Often, after making a statement, the authors anticipate myriad possible misinterpretations or overgeneralizations and clear them up one by one. I was also favorably impressed by the 2406 references listed in the book.

The authors conclude, perhaps controversially, that even though the surface term can be estimated from experiments, such estimates are uncertain, mainly because "bulk and surface effects are simply *not unambiguously partitionable*." They further conclude that the ambiguous partitioning affects all single-ion thermodynamic properties,



though that's not surprising since all thermodynamic properties can be written as functions of the free energy and its derivatives.

Single-Ion Solvation is clear and lighthearted. The book is illustrated with clever cartoons. I enjoyed the authors' wry comment about the large number of extrathermodynamic assumptions that have been advocated: "They always sound intuitively reasonable, at least to their author." But they do not lose sight of the serious implications of single-ion solvation, and they conclude that the numerous approaches and their associated conventions and often ambiguous specifications are "a constant source of mistakes in the field." A clear understanding of the material in this book would minimize those mistakes.

The authors make a number of recommendations, such as the use of "real" and "intrinsic" to distinguish free energies that respectively do and do not include the surface term. I prefer that approach to avoiding mention of the issue or using the ambiguous term "absolute" or the jargon term "galvanic." I also heartily agree with their observation that physical interpretation is more straightforward for what they call semi-standard point-to-point solvation parameters (as opposed to standard-state ones): They distinguish those quantities by a large and a small circle, respectively, in the state symbol, whereas in my own papers I employ the notations ΔG_s^* and ΔG_s^0 . That might be the only place in the book where I think the pedagogy can be improved: The authors never point out that ΔG_s^* corresponds to solvation in a surface-free fluid at a fixed concentration (the same number of moles per liter in the vapor and in solution). Among other benefits, fixed-concentration solvation has a clearer physical interpretation than standard-state solvation because, as emphasized by physical chemist Arieh Ben-Naim, under such conditions the entropy of translation in the vapor equals the entropy of liberation from a fixed point in solution. Therefore, the free-energy change can be directly related to the work of coupling the solute to the solvent.

One thing I did not like about the book is that many tables are printed in a small font and therefore hard to read. Also, the text font itself is small and light, at least in my copy. The publisher should do a better job.

For aficionados, *Single-Ion Solvation* is a little bit like a mystery book; it

leaves readers anticipating what values the authors will ultimately recommend for key quantities. Spoiler alert! For an aqueous solution, they recommend a surface potential of +0.13 V, and for a proton in water, an intrinsic semi-standard point-to-point solvation free energy of -265 kcal/mol.

Donald G. Truhlar
University of Minnesota
Minneapolis

new books

materials science

Characterization of Terahertz Emission from High Resistivity Fe-doped Bulk $\text{Ga}_{0.69}\text{In}_{0.31}\text{As}$ Based Photoconducting Antennas. S. Sengupta. *Springer Theses*. Springer, New York, 2011. \$99.00 (77 pp.). ISBN 978-1-4419-8197-4

Computational Studies of Transition Metal Nanoalloys. L. O. Paz Borbón. *Springer Theses*. Springer, Berlin, 2011. \$129.00 (155 pp.). ISBN 978-3-642-18011-8

Glassy Materials and Disordered Solids: An Introduction to Their Statistical Mechanics. Rev. ed. K. Binder, W. Kob. World Scientific, Hackensack, NJ, 2011 [2005]. \$107.00 (547 pp.). ISBN 978-981-4350-17-4

Light-Induced Processes in Optically-Tweezed Aerosol Droplets. K. J. Knox. *Springer Theses*. Springer, Berlin, 2011. \$129.00 (204 pp.). ISBN 978-3-642-16347-0

The Mathematics and Topology of Fullerenes. F. Cataldo, A. Graovac, O. Ori, eds. *Carbon Materials: Chemistry and Physics* 4. Springer, New York, 2011. \$129.00 (289 pp.). ISBN 978-94-007-0220-2

Multifunctional Polycrystalline Ferroelectric Materials: Processing and Properties. L. Pardo, J. Ricote, eds. *Springer Series in Materials Science* 140. Springer, Dordrecht, the Netherlands, 2011. \$219.00 (782 pp.). ISBN 978-90-481-2874-7

Physical Properties of Ceramic and Carbon Nanoscale Structures: The INFN Lectures, Vol. 2. S. Bellucci, ed. *Lecture Notes in Nanoscale Science and Technology* 11. Springer, Berlin, 2011. \$129.00 (197 pp.). ISBN 978-3-642-15777-6

Relaxation and Diffusion in Complex Systems. K. L. Ngai. *Partially Ordered Systems*. Springer, New York, 2011. \$199.00 (835 pp.). ISBN 978-1-4419-7648-2

miscellaneous

Doing Physics: A Festschrift for Thomas Erber. P. W. Johnson, ed. Illinois Institute of Technology, Chicago, 2010. \$25.00 *paper* (294 pp.). ISBN 978-1-61597-000-1

nonlinear science and chaos

IUTAM Symposium on Nonlinear Stochastic Dynamics and Control. W. Q.

Zhu, Y. K. Lin, G. Q. Cai, eds. *IUTAM Book Series* 29. Proc. symp., Hangzhou, China, May 2010. Springer, New York, 2011. \$139.00 (328 pp.). ISBN 978-94-007-0731-3

nuclear physics

Polarized Sources, Targets and Polarimetry: Proceedings of the 13th International Workshop. G. Ciullo, M. Contalbrigo, P. Lenisa, eds. Proc. wksp., Ferrara, Italy, Sept. 2009. World Scientific, Hackensack, NJ, 2011. \$126.00 (337 pp.). ISBN 978-981-4324-91-5

optics and photonics

Controlling Light in Optically Induced Photonic Lattices. B. Terhalle. *Springer Theses*. Springer, Berlin, 2011. \$129.00 (104 pp.). ISBN 978-3-642-16646-4

Crystals, X-rays and Proteins: Comprehensive Protein Crystallography. D. Sherwood, J. Cooper. Oxford U. Press, New York, 2011. \$98.50 (621 pp.). ISBN 978-0-19-955904-6

An Introduction to Quantum Optics: Photon and Biphoton Physics. Y. Shih. *Series in Optics and Optoelectronics*. CRC Press/Taylor & Francis, Boca Raton, FL, 2011. \$69.95 (464 pp.). ISBN 978-0-7503-0887-8

Light Propagation in Gain Media: Optical Amplifiers. M. Premaratne, G. P. Agrawal. Cambridge U. Press, New York, 2011. \$99.00 (270 pp.). ISBN 978-0-521-49348-2

Mathematical Methods for Optical Physics and Engineering. G. J. Gbur. Cambridge U. Press, New York, 2011. \$90.00 (800 pp.). ISBN 978-0-521-51610-5

particle physics

XI Hadron Physics. M. Nielsen, F. S. Navarra, M. E. Bracco, eds. *AIP Conference Proceedings* 1296. Proc. mtg., São Paulo, Brazil, Mar. 2010. AIP, Melville, NY, 2010. \$224.00 *paper* (433 pp.). ISBN 978-0-7354-0848-7

The CBM Physics Book: Compressed Baryonic Matter in Laboratory Experiments. B. Friman et al., eds. *Lecture Notes in Physics* 814. Springer, Berlin, 2011. \$159.00 (980 pp.). ISBN 978-3-642-13292-6

Discovery of Single Top Quark Production. D. Gillberg. *Springer Theses*. Springer, New York, 2011. \$129.00 (142 pp.). ISBN 978-1-4419-7798-4

Exclusive Reactions at High Momentum Transfer IV. A. Radyushkin, ed. Proc. wksp., Newport News, VA, May 2010. World Scientific, Hackensack, NJ, 2011. \$175.00 (471 pp.). ISBN 978-981-4329-55-2

An Introduction to String Theory and D-Brane Dynamics: With Problems and Solutions. 2nd ed. R. J. Szabo. Imperial College Press, London, 2011 [2004]. \$68.00 (148 pp.). ISBN 978-1-84816-622-6

An Introduction to the Confinement

Problem. J. Greensite. *Lecture Notes in Physics* 821. Springer, Berlin, 2011. \$59.95 *paper* (211 pp.). ISBN 978-3-642-14381-6

Muonium-Antimuonium Oscillations in an Extended Minimal Supersymmetric Standard Model. B. Liu. *Springer Theses*. Springer, New York, 2011. \$109.00 (67 pp.). ISBN 978-1-4419-8329-9

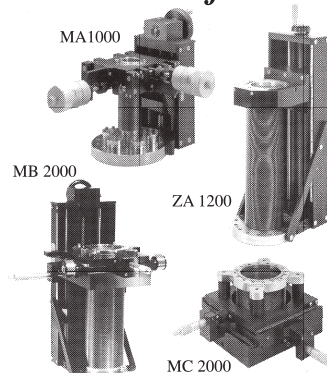
The Pinch Technique and Its Applications to Non-Abelian Gauge Theories. J. M. Cornwall, J. Papavassiliou, D. Binosi. *Cambridge Monographs on Particle Physics, Nuclear Physics and Cosmology* 31. Cambridge U. Press, New York, 2011. \$115.00 (286 pp.). ISBN 978-0-521-43752-3

Predicted and Totally Unexpected in the Energy Frontier Opened by LHC: Proceedings of the International School of Subnuclear Physics. A. Zichichi, ed. *The Subnuclear Series* 46. Proc. sch., Erice, Italy, Aug.-Sept. 2008. World Scientific, Hackensack, NJ, 2011. \$238.00 (673 pp.). ISBN 978-981-4340-20-5

Proceedings of the Fifth Meeting on CPT and Lorentz Symmetry. V. A. Kostelecký, ed. Proc. mtg., Bloomington, IN, June-July 2010. World Scientific, Hackensack, NJ, 2011. \$118.00 (298 pp.). ISBN 978-981-4327-67-1

Strong Coupling Gauge Theories in LHC Era. H. Fukaya, M. Harada, M. Tanabashi, K. Yamawaki, eds. Proc. wksp., Nagoya, Japan, Dec. 2009. World Scientific, Hackensack, NJ, 2011. \$150.00 (440 pp.). ISBN 978-981-4329-51-4

The ABCs of X-Y-Zs



PRECISION X-Y-Z MANIPULATORS

- Up to 2" (50mm) X-Y travel standard
- 1.39 - 4.0" bellows ID standard
- Bakeable to over 200°C (without removing micrometers)
- Easy access X micrometer and Z scale may be mounted on either side
- Z axis strokes from 2 - 36" standard
- A style for every application

Call 1-800-445-3688 for more information.

McAllister Technical Services
Manufacturers of surface analytical instruments and devices

West 280 Prairie Avenue
Coeur d'Alene, Idaho 83814