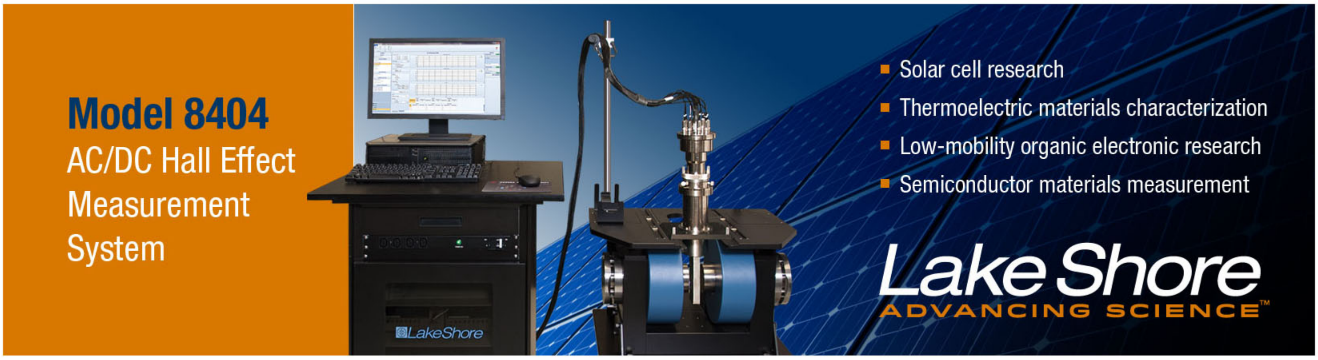
Physics Today

Physics of the Future: How Science Will Shape Human Destiny and Our Daily Lives by the Year 2100

Neil Gershenfeld

Citation: Physics Today 64(10), 56 (2011); doi: 10.1063/PT.3.1299
View online: http://dx.doi.org/10.1063/PT.3.1299
View Table of Contents: http://scitation.aip.org/content/aip/magazine/physicstoday/64/10?ver=pdfcov
Published by the AIP Publishing



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.

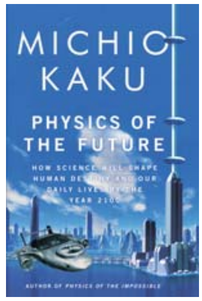
The result, alas, is a kind of future by committee. We're told that in the future there will be real-time spoken language translators; in the present there's an app for that. The book ends with a scenario of a day in the life in 2100 that features such science-fiction staples as magnetically levitating (maglev) cars, wristwatch 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