American Journal of Physics

BOOK REVIEWS | NOVEMBER 01 2018

BOOKS RECEIVED

Am. J. Phys. 86, 880 (2018)
https://doi.org/10.1119/1.5058772

BOOK REVIEWS

The downloaded PDF for any Review in this section contains all the Reviews in this section.

Craig F. Bohren, *Editor*
Pennsylvania State University, University Park, Pennsylvania 16802; mailing address: P.O. Box 887, Boalsburg, PA 16827; bohren@meteo.psu.edu

The Man Who Saw Tomorrow: The Life and Inventions of Stanford Ovshinsky. Lillian Hoddeson and Peter Garrett. 392 pp. MIT Press, Cambridge, MA, 2018. Price: $29.95 (hardcover). ISBN 9780262037532. (Brian Schwartz, Reviewer.)

In the Jewish tradition and folklore, there is a belief that in every generation, roaming the face of the Earth, there are 36 righteous and exceptionable people upon whose actions the world is kept from chaos. These 36 people are known as *lamed vav* from the Hebrew language alphabet letters representing the numbers (*lamed* ל = 30 and *vav* ו = 6). No one knows who they are, and they themselves are unaware of their exceptionality. They are simply good people who do good things on behalf of humankind. They are filled with compassion. They are the very best among us. I maintain that Stanford Ovshinsky was one of the *lamed vav*, and the biography *The Man who Saw Tomorrow: The Life and Inventions of Stanford Ovshinsky* provides proof for the legend.

The biography is authored by Lillian Hoddeson who is a historian of science and the English Professor Peter Garrett, both emeriti at the University of Illinois at Urbana-Champaign. Hoddeson is a specialist in the history of physics and technology during the second half of the 20th century and is the co-author of the biography *True Genius: The Life and Science of John Bardeen: The Only Winner of Two Nobel Prizes in Physics*. Professor Hoddeson is well versed in understanding the science and the significant role Stan Ovshinsky played in materials sciences and their importance in the technologies he invented and developed.

Like any good biography, the story of Stanford Ovshinsky starts with his early formative years, being born to European immigrant parents in 1922, and growing up poor in the industrial city of Akron, OH. His father Ben was influential as Stan received his early introduction to metals and machining by working with his father in the collection of scrap metals. Ben also influenced Stan's social consciousness through his union activities and the role of the Workman's Circle (*Der Arbeter Ring)* which was founded by progressive-minded immigrants in 1900. The aim of the Workman's Circle was to create a better and more beautiful world by emphasizing community and social justice. Stan not only saw tomorrow through his inventions but also saw the future in terms of how to treat and respect his workers. Throughout his early career, Stan was very active in union organizing which sometimes got him into serious conflicts with his employers and at times literally putting his life at risk. One example was a dangerous confrontation that occurred when Stan helped organize a non-violent one-day strike at a Goodrich tire plant, and a car drove straight at him.

Stan's first invention was the Benjamin Center Driven Lathe, named after his father. This was a significant advance in a comprehensive machining tool that utilized Stan's creative and inventive processes. This invention was the start of his first major business adventure that ultimately led to the establishment of his company Energy Conversion Devices (ECD).

At this point in the book, the narrative gets more personal and intimate and introduces the love story between Stan and Iris Miroy Dibner. In 1955, both Stan and Iris were struck hard by Cupid's arrows and both ultimately left their first marriages. From then on and for the next 51 years, Stan and Iris were inseparable in their personal and work lives. They married formally in 1962. The closest example one could give for a similar public display of Stan and Iris' love would be the relationship between Ronald and Nancy Reagan. Iris, unlike Stan, had a good deal of formal education with a Ph. D. degree in biochemistry. Her scientific credentials were important for the encouragement of Stan's ideas on synapses and nerve impulses devices and in the formality required for the writing of technical papers. Iris played a crucial partnership role in all aspects of business, family, and social life with Stan.

Stan and Iris were way ahead of their time in terms of fair employment practices, equality in hiring, in housing, education, and many more of the most up to date human resources practices of many of today's enlightened companies. As one example, when a black employee he hired for his company was denied housing due to discrimination, Stan and Iris bought the house and resold it to their employee. Thus, Stan was also the "Man Who Saw a More Socially Conscious Tomorrow" and implemented these values within his working community.

Stan's first company was based on his invention of a switching device which he named the Ovitron. The switch resembled a battery and was modeled after Ovshinsky's view of a neuron transmission circuit. In 1960, Stan and Iris set up a new company that ultimately led to the development of a switching device made from amorphous chalcogenide materials. The book traces the many steps that led to the use of amorphous materials and to the development of the Ovonic Threshold Switch and the now famous and controversial single-authored Ovshinsky paper *Revisable Electrical Switching Phenomena in Disordered Materials*. The paper appeared in the November 11, 1968 issue of the peer-reviewed journal *Physical Review Letters* and was also reported on the front page of The New York Times. The biography details the very hostile reception his paper received from the established physics community. Despite the angry response and unorthodox announcement of the discovery in the Times, Ovshinsky gets credit for the development of the field of amorphous materials and devices.

Ovshinsky got crucial early assistance from first-rate scientists and consultants such as Helmut Fritzsche, Morrel Cohen, David Adler, and the Nobel Laureate Sir Nevill Mott. In those early days of ECD (and even later), Ovshinsky was accused by some of being a self-promoting charlatan. I disagree. Knowing Stan and his "relationship" with the periodic table of the elements, I would call him more of an alchemist in the most positive sense as in a quote by the psychoanalyst Carl Jung: "Alchemy represents the projection of a drama both cosmic and spiritual in laboratory terms. The opus magnum [the great work] had two aims: the rescue of the human soul and the salvation of the cosmos."

From that point on, there were many inventions and products developed at Energy Conversion Devices under the leadership of Stan Ovshinsky. The stories behind the funding of the research and the ambitious engineering challenges presented are exciting and often nail-biting. Their book details many examples of the struggles ECD faced with meeting its payroll, the engineering challenges, and the needed heroic efforts Stan and his workers had to make.

The middle chapters of the book go into details about Stan, Iris, and ECD's contributions to major programs in the developments of solar energy; the hydrogen economy and batteries; and information: displays and memory devices. A concise review of the entrepreneurial style and cooperative inventiveness and product development is presented in a recent review article by Hoddeson and Garett in Physics Today[1] under the title *The Discovery of Ovshinsky Switching and Phase-Change Memory*.

Ovshinsky had a unique ability to recognize the potential of the many scientists, engineers, technicians, and consultants he personally hired for ECD. The authors go into great detail documenting the contributions of various key people to specific programs. (*Full Disclosure*: I was hired as a consultant to ECD in the mid 1980s and helped run an outreach program as director of the Institute for Amorphous Studies. Thus I had first-hand knowledge of and interactions with some of the people that worked for Stan and ECD that are described in the book.) One of Stan's exceptional qualities was his ability to recognize the unique talents in his employees and then target the responsibilities and challenges he gave them. I was continually impressed with the authors' brief but accurate descriptions of the key employees and consultants and their contributions as well as their personalities and idiosyncrasies. The authors' writings and descriptions of the many inventions, technical solutions, and science associated with ECD's contributions were always very clear, accurate, and concise.

The last parts of the book are a tale of loss, new love, and finally, the last days of Stan and the ending of some of his dreams. The uplifting parts are the significant science and technology he was able to achieve[2] and the richness and passion of the life he led.

After his death in 2012, at age 90, he was posthumously inducted into the 2015 National Inventors Hall of Fame that recognizes inventors who have changed the world through human, social, and/or economic progress. His citation reads, "Stanford Ovshinsky was a prolific inventor who specialized in amorphous materials that resulted in dramatic improvements in battery technology, electronics and solar power. Ovshinsky had more than 400 United States and international patents, including many related to the nickel-metal hydride battery and the field of alternative energy."

I recommend the book to anyone interested in a good story of a life well lived with great challenges and passions. There are so many different textures and incidences in Stan's life and work that I believe the book would make a dramatic novel-like film of great interest to a wide-audience. My brief summary of Stanford Ovshinsky is: he lived his life as a *mensch*.

[1]Lillian Hoddeson and Peter Garrett, "The discovery of Ovshinsky switching and phase change memory," Phys. Today **71**(6), 44–51 (2018).
[2]Sanford R. Ovshinsky, *The Science and Technology of an American Genius*, edited by Helmut Fritzsche and Brian Schwartz (World Scientific Publishing, Singapore, 2008).

Brian Schwartz is a Professor of Physics at Brooklyn College and The Graduate Center of the City University of New York. His research is in the areas of condensed matter physics, science communication, and physics education.

The Great Silence: The Science and Philosophy of Fermi's Paradox. Milan M. Ćirović. 422 pp. Oxford U. P., New York, 2018. Price: $32.95 (hardcover). ISBN 978-0-19-964630-2. (G. David Brin, Reviewer.)

Our perceptions of reality are framed by notions about cosmic structure. Ancestral mythologies often credited the world's existence to a creator deity, who might un-make what had been made. Or else they envisioned a world whose life cycle, like a person's, might have a foretold end. Nowadays, the Universe as a whole seems safe till the Great Dissipation, yet we peer for patterns that might portend more immediate peril.

One such pattern—formerly confined to science fiction—now inveigles into scholarly argument and even debates over public policy. The "Fermi Paradox" was named in the late 1980s after the celebrated physicist who—thirty years earlier—famously asked: "So, where *are* all those aliens?" Rough calculations suggested that our Galaxy should be aswarm with signs of earlier civilizations. Their apparent absence—if not exactly a "paradox"—is certainly a puzzle.

As yet, the Search for Extra-Terrestrial Intelligence (SETI) has found no plausible glimmers. After sifting for "needles in the Galactic haystack" across an entire human lifespan with rapidly improving tools and methods, we've glimpsed none of the extravagant radio beacons depicted in the movie CONTACT. No sign (so far) of robotic-interstellar probes. No hints in our Solar System that past visitors altered asteroids or their orbits, or of colonizations in Earth's geological or paleontological record, the sort of spoor that humanity is copiously laying today, amid the Anthropocene Era. This apparent loneliness might end tomorrow, or in a decade or century—the search remains worthwhile—but we do know enough already to say there's no gaudy-welcoming

bustle out there. Indeed, we seem like toddlers, venturing forth into a forest that's quiet… maybe *too quiet*.

Among the many Fermi-hypotheses out there (or "fermis") are gloomy scenarios issued by the likes of Stephen Hawking (e.g., all ecosystems feature predation, and if you don't know you're a predator, then you are prey)… or author Liu Cixin (in a dark forest, it's prudent to eliminate potential rivals first)… or groups in Oxford and Cambridge who study "existential risk," suggesting that some Great Filter lies ahead—a minefield of systematically fatal errors that trap nearly all promising, young civilizations.

Everyone, it seems, has their own notion or theory, but only rarely have efforts been made to catalogue and compare, putting some order to this quandary, perhaps the most significant we'll ever face. Back in a 1983 review for Quarterly Review of the Royal Astronomical Society, I listed and ranked hypotheses for what I called *"The Great Silence,"* before consensus settled on a different name. In 2002, Stephen Webb's catalogue *"Where is Everybody? Fifty Solutions to Fermi's Paradox"* was another effort at perspective, as were Michael Michaud's substantial *Contact With Alien Civilizations* and *The Eerie Silence* by Paul Davies.

Now, Belgrade astronomer Milan M. Ćirković goes even deeper in *"The Great Silence: The Science And Philosophy Of Fermi's Paradox,"* performing a much-needed critical analysis of the many logical and philosophical fallacies that pervade this field—the most important scientific topic that lacks any known subject matter.

Ćirković pays due homage to the famed "equation" of SETI pioneer Frank Drake which—for all its faults—helped frame our disorderly arguments about ETC (Extra-Terrestrial Civilization). Evidently, one factor or several must be small, in order to explain why the number of known, sapient species in the cosmos still hovers around one. (Depending on your definition of "sapient" and "known.") Hence, while members of the gloom/risk community expect low values for "L"—the average lifespan of a technological race—others assert we're over-estimating f(L), or the likelihood that life erupts elsewhere in the cosmos. Despite decades spent discovering one easy biochemical step after another, we may yet find that some as-yet undiscovered crucial link was an improbable fluke, leading to just one lonely world that's not sterile, but green.

(As nearby planetary systems are surveyed with advanced spectroscopic tools, f(L) may be the next factor to clarify.)

Or else the low, suppressing Drake factor may be "f(I)," the fraction of fecund, life-bearing worlds that ever host an intelligent, then an ambitiously and detectably technological species.

Other once-mysterious factors have surrendered to science. Twenty years ago, we knew of no extra-solar planets; now more than 4000 are confirmed, and that figure should soon leap by an order of magnitude. Now add another discovery, that our solar system contains not one ice-roofed ocean world (Europa), but as many as ten! This implies that life may exist near any and every star, not just those with a balmy "Goldilocks Zone."

Casting a wide, encompassing net, Ćirković looks critically at the family of "Zoo Hypotheses" —proposing that ETCs *do* exist out there but have deliberately masked themselves from our sight for some reason. Variations are myriad and the author cites several—e.g., that advanced ETCs might enforce a Star Trek-like "prime directive" banning interference in primitive civilizations such as ours. Among potential motivations for such interdiction may be ethics, or pity, or preservation of a scarce resource. (Perhaps young, struggling societies like ours provide a rich supply of drama, helping to stave off cosmic ennui.) Or the drive may be economic; so long as we blare free samples of our rich culture, they feel uncompelled to reciprocate. Alternatives abound.

Ćirković takes the reader on a journey, appraising claims that there's something special about our place in the Galaxy (just far enough from the Galactic core to escape intermittent incineration) or this particular time (our third-generation solar system has plenty of metals). While some protest that "special circumstance" contravenes the Copernican Principle of Mediocrity, Ćirković has a stronger objection—that time-or-place selection seems to violate Non-Exclusivity. Any effect or process that merely reduces the number of ETCs linearly won't suffice—not by itself—because it is *exceptions* that will spread far and wide, inheriting the galaxy. In order to have explanatory power, a solution to Fermi's Paradox must be fierce and nonlinear—allowing few exceptions—or else work in tandem with others to cull the number of ETCs way down into single digits. Or just one.

What about such effects working in tandem? Some combination of traits may have been anomalously favorable on Earth. Some propose that our comparatively large moon may have been significant. I've mentioned the way our planet skates along the very inner edge of the sun's Continuously Habitable Zone, perhaps making it atypically dry and oxygen rich, for an open-ocean world. Ćirković speculates that a combination of many factors may be responsible both for earlier silence and then for a following astrobiological "phase transition," for which it's statistically possible for humanity to be a vanguard.

A related matter—the controversy over METI, or *Messaging* to ETI—is covered in less depth, since it is primarily about grownup behavior (or its lack) down here on Earth… whether small groups of zealots should bypass all institutions, peer critique, risk appraisal or public opinion, to shout "yoohoo" into a potentially hazardous cosmos. Ćirković's book offers plenty of grist for discussion and consensus-seeking, before rushing to force a fait accompli on our children.

From the Gaia Hypothesis to Rare Earth models, to various "great filters," to a Galaxy dominated by machines… all the way to a putative attractor state of "transcendence" that might pull advanced ETCs away from lifestyles we'd observe… the truly remarkable thing here is how many concepts are now fodder for legitimate discussion that were formerly restricted to science fiction. (Full-disclosure, I've used nearly all of them as plot drivers in varied stories and novels.) Ćirković shows that the topic is so broad, with so many implications, that it ultimately distills down to an appraisal

of *us*. Of contemporary humanity in all our complexity and contradiction, our obduracy and brilliance in confronting a tsunami of accumulating knowledge… and awareness that all these speculations will (must) seem childishly naïve from the perspective of our heirs.

That's all right. It is our verve and curiosity and eager gregariousness that make us interesting, propelling speculative extravaganzas like *The Great Silence*. Moreover, even if it all serves as reality-show entertainment for bored, alien-voyeur couch potatoes, well, fine. We still want our royalties.

And we're coming.

David Brin is an astrophysicist whose novels include The Postman, Earth, and Existence. He serves on advisory boards (e.g., NASA's Innovative and Advanced Concepts program or NIAC) and speaks or consults on topics ranging from AI and SETI to privacy and national security. His nonfiction book about the information age—The Transparent Society—won the Freedom of Speech Award of the American Library Association.

BOOKS RECEIVED

Galileo Unbound: A Path Across Life, the Universe, and Everything. David D. Nolte. 366 pp. Oxford U.P., New York, 2018. Price: $32.95 (hardcover) ISBN 978-0-19-880584-7.

Science and Humanity: A Humane Philosophy of Science and Religion. Andrew Steane. 299 pp. Oxford U.P., New York, 2018. Price: $32.95 (hardcover) ISBN 978-0-19-882459-9.

The Age of Innocence: Nuclear Physics Between the First and Second World Wars. Roger H. Stuewer. 499 pp. Oxford U.P., New York, 2018. Price: $55 (hardcover) ISBN 978-0-19-882787-0.

Physics and Technology of Sustainable Energy. E. L. Wolf. 425 pp. Oxford U.P., New York, 2018. Price: $75 (hardcover) ISBN 978-0-19-876980-0.

High Time-Resolution Astrophysics. Tariq Shahbaz, Jorge Casares Veláquez, and Teodoro Muñoz, Eds. 210 pp. Cambridge U.P., New York, 2018. Price: $140 (hardcover) ISBN 978-1-107-18109-0.

The Physics of Energy. Robert L. Jaffe and Washington Taylor. 895 pp. Cambridge U.P., New York, 2018. Price: $79.99 (hardcover) ISBN 978-1-107-01665-1.

Introduction to Quantum Mechanics, 3rd ed. David J. Griffiths and Darrell F. Schroetter. 508 pp. Cambridge U.P., New York, 2018. Price: $74.99 (hardcover) ISBN 978-1-107-18963-8.

Quantum Field Theory and Condensed Matter: An Introduction. R. Shankar. 453 pp. Cambridge U.P., New York, 2018. Price: $74.99 (hardcover) ISBN 978-0-521-59210-9.

A Brief History of Astronomy and Astrophysics. Kenneth R. Lang. 338 pp. World Scientific, Singapore, 2018. Price: $48 (paper) ISBN 978-981-3235-9.

Introduction to Solid State Physics. Amnon Aharony and Ora Entin-Wohlman. 637 pp, World Scientific, Singapore, 2019. Price: $148 (hardcover) ISBN 978-981-3272-8.

Networks, 2nd ed. Mark Newman. 791 pp. Oxford U.P., New York, 2018. Price: $65 (hardcover) ISBN 978-0-19-880509-0.

Max the Demon vs Entropy of Doom. Assa Auerbach and Richard Codor. 135 pp. Loose Line Productions, 2017. Price: $24.95 (paper) ISBN 978-0-9799218-5-8.